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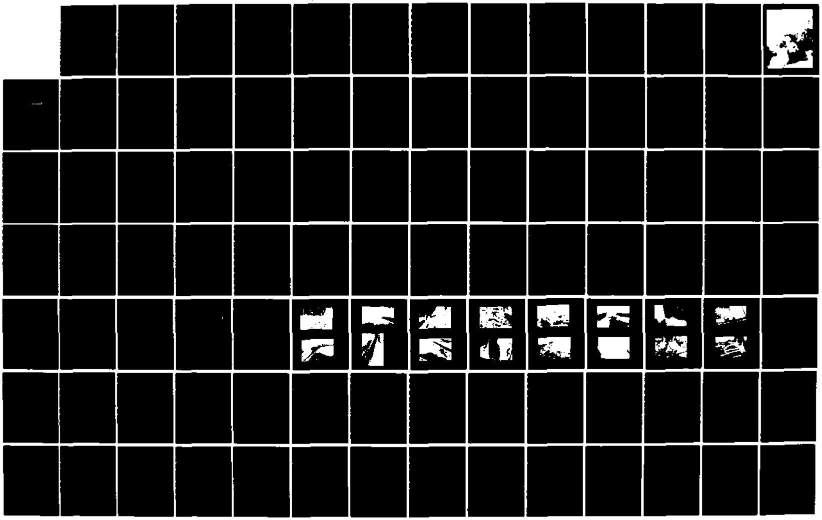

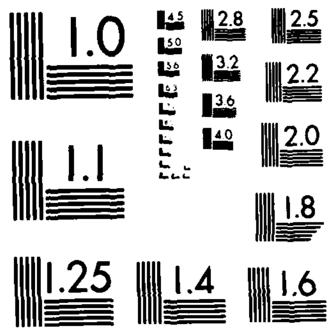

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WOODBURY, VT

NICHOLS POND DAM
VT 00184

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

APRIL 1980

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    DAMS, INSPECTION, DAM SAFETY,

    Richelieu River Basin
    Woodbury VT.
    Nochols Brook
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

THe dam is a 200 ft. long, 18 ft. high earth and masonry structure. The visual inspection of the dam revealed some minor problems. THe general condition of the dam is considered fair. The dam is intermedaite in size with a high hazard potential. There are a few recommendations which must be undertaken by the owner.

NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification Number:	00184
Name of Dam:	Nichols Pond Dam
Town:	Woodbury
County and State:	Washington, Vermont
Stream:	Nichols Brook
Date of Inspection:	October 25, 1979

Nichols Pond Dam is a 200-foot-long, 18-foot-high earth and masonry structure. The dam was originally constructed in about 1900 to provide water supply for the generation of hydroelectric power at Mackville Dam, 2½ miles downstream. Water from Nichols Pond currently augments flows at Pottersville Dam on the Lamoille River. There is a concrete chute spillway approximately in the center of the earth structure which controls normal outflow. There is no emergency spillway and the service spillway is only 7' - 3" wide at its downstream end. Reportedly, a rectangular sluice (2 ft by 5 ft) controlled by two hand operated gates is located underneath the service spillway. The only engineering information available on the structure consisted of past inspection reports by two bureaus of the State of Vermont. There are no design calculations or construction data available.

The visual inspection of Nichols Pond Dam revealed some minor problems. The general condition of the dam is considered fair. The inspection revealed erosion on the crest of the dam, a large mass of debris that deflected flows toward the base of the downstream face, trees growing on the crest and overhanging the downstream channel, deterioration of the gate operating mechanism, no emergency spillway and trespassing on the crest. Based on the dam's Intermediate size and High hazard classification in accordance with the Corps' guidelines, the test flood is the full PMF. The test flood for a drainage area of 4.6 square miles is approximately 8,300 cfs. Storage provided by the pond (1,335 acre-feet) will attenuate the test flood to a projected outflow of 5,870 cfs which will overtop the dam by 5.0 feet. The spillway will discharge 218 cfs (3.7% of the routed test flood outflow) with a water level at the top of the dam.

It is recommended that the owner engage a qualified registered engineer to design appropriate structures to control erosion at the base of the spillway and control the accumulation of debris, examine both upstream and downstream faces where not presently visible, perform a hydraulic analysis of the spillway, design an emergency spillway, evaluate the gate structure, and initiate an active maintenance program. The owner should develop a formal surveillance and downstream flood warning plan, including round-the-clock monitoring during heavy precipitation.

The recommendations and remedial measures are described in Section 7 and should be addressed within one year after receipt of this Phase I Inspection Report by the owner.

Very truly yours,

DuBois & King, Inc.

COMMONWEALTH OF
REGISTERED
PROFESSIONAL
JOHN J. BILOTTA

John J Bilotta

John J. Bilotta, P.E.
Project Manager

JJB/tdc

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably-possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that

a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual observations did not disclose any indications of present structural instability. Undermining of the downstream wall next to the spillway, if worsened, could endanger the future stability of the dam. The debris at the spillway outfall prevented the gathering of data for an analysis of the sluice structure.

6.2 Design and Construction Data

There is practically no design and construction data available. Thus it is not possible to perform a formal analysis of the stability of the dam. A report of an inspection performed by the Public Service Commission in 1949 provides some details but the data is insufficient to perform any analysis.

6.3 Post Construction Changes

There are no post construction changes noted in the available records except for the repairs to the concrete of the upstream concrete face and spillway. The repaired concrete was observed to be in good condition.

6.4 Seismic Stability

The dam is located in Seismic Zone 2 and in accordance with the Phase I inspection guidelines does not warrant seismic analysis.

5.3 Experience Data

There are no recorded experiences of overtopping or any visual accounts of such. However, the rather limited capacity of the spillway (218 cubic feet per second) would tend to indicate that overtopping would occur on frequent basis. The scour or erosion noted on the top of the dam adjacent to the spillway may be an indication of overtopping.

1/2 PMF analysis also required for high hazard dam. Summarize

5.4 Test Flood Analysis

The storage capacity of this structure (2840 acre-feet) puts it in the Intermediate size category. The hazard classification is High, since failure of Nichols Pond is likely to endanger the lives of more than a few people at Mackville and result in subsequent overtopping of Mackville Dam (two miles downstream). A failure of Nichols Pond Dam would likely endanger occupants of five dwellings located near Mackville Pond. Based upon "Recommended Guidelines for Safety Inspection of Dams" the test flood is the full Probable Maximum Flood (PMF). The drainage area for Nichols Dam consists of a regulated drainage area (3.4 square miles is controlled by East Long Pond Dam) and an independent drainage area (1.1 square miles). The PMF inflow to Nichols was obtained by adding the routed test flood outflow from East Long Pond Dam to the inflow projected from the independent drainage area. The PMF envelope curve for Mountainous Areas was used to project inflows for the two drainage areas. The resulting test flood inflow (8300 cfs) for Nichols dam was then routed through the reservoir assuming the water surface to be initially at the crest of the dam (elevation 1130.5 NGVD). Calculations indicate that the dam would be overtopped by 5.0 feet (elevation 1135.5 NGVD). The resulting storage (1335 acre-feet) would attenuate the inflow to 5870 cfs outflow. ~~The routed test flood outflow (5870 cfs) represents a 29% reduction of the test flood inflow.~~

of dam.

previously commented → Give spillway capacity at top of dam and perc. tage of routed test flood outflow spillway can carry at top of dam.

5.5 Dam Failure Analysis

Utilizing the Corps' April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs," a dam failure analysis was performed for Nichols Pond. Prior to failure, the water level was assumed to be at the crest of the dam (1130.5 NGVD) and the breach height (upstream toe to water surface) would be 20 feet. A breach width of 70 feet was used in the Saint-Venant equation to compute a breach outflow of 10,500 cfs.

The breach would produce a 11.9-foot high flood wave and the resultant stage of Nichols Brook would be 13.7 feet above streambed at the initial impact area. Approximately two miles downstream lies Mackville Dam. The flood wave would cause subsequent overtopping of Mackville Dam. Appreciable damage could occur to five dwellings located at Mackville with flood levels up to five feet above the first floor of some of those dwellings. Another residential area one-half mile further downstream than Mackville has about ten more residences that would be subject to damages resulting by an 11.6-foot high flood wave. Further downstream the outskirts of Hardwick Village would be subjected to a flood wave 6.8 foot high. It is likely that more than a few lives may be lost if Nichols dam is breached, and therefore the dam is classified as High hazard.

SECTION 5
EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Nichols Pond has a fixed crest weir for a principal spillway 37.0 feet wide set at elevation 1128.0. There is a 9 feet wide notch in the crest approximately 6-inches deep. The notch tapers to the width of 7 feet 3-inches and an elevation of 1126.0 at the downstream face. The only outlet for water at the downstream face of the spillway is a notch 7 feet 3 inches wide and 4 feet high. For various flows in the small range, the control for the pool level varies from the upstream to the downstream end. For flows less than 100 cfs, the upstream end of the spillway represents the control. For flows greater than 100 to 150 cfs, the downstream 4 feet deep notch represents the control of the spillway. It is suspected that when flow over the spillway is in a range of 75 to 150 cfs a hydraulic jump may occur in the middle of the spillway. Evidence of this phenomenon is represented by a scour mark approximately three-quarters of the way down the notch in the spillway.

The pond outlet is controlled by two gates with wooden stems which rise vertically in the center of the spillway in the upstream face. There is no information available on the size or invert of the outlet structure. Consequently, no rating or other analysis was performed for the outlet. The location of the gate operating mechanism in the center of the spillway would obviously prevent gate operation during periods of high water.

The watershed of Nichols Pond is relatively steep mountainous terrain covered for the most part with trees and forests. Approximately one-half mile upstream from Nichols Pond lies another large (for this watershed) lake named East Long Pond. The combination of East Long Pond and Nichols Pond have a total lake area at full pool of 350 acres. This represents 12 percent of the total watershed. It is likely that this large lake area will attenuate flood peaks. Both East Long Pond and Nichols Pond are owned and operated by the Village of Hardwick.

5.2 Design Data

The data on the hydrologic design of Nichols Pond Dam is not available. However, a preliminary analysis of the hydraulic characteristics of the spillway indicate that hydraulic control may switch from the upstream face to the throat of the spillway. This may result in a hydraulic jump occurring in the middle of the spillway.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. Operational Procedures consists primarily of opening the gates in the summer time in order to augment flows to the power dam downstream on the Lamoille River. In order to operate the sluice gates, the operator must stand on the crest of the spillway and use a large wrench to turn the ratchet which raises and lowers the timbers attached to the gates. The wrench is kept at the Village maintenance shed approximately three miles downstream. There is no written procedure for lowering the pool level or opening the gates in preparation for a possible flooding event. A 1949 inspection report by an engineer for the Public Service Commission warned that both East Long Pond and Nichols Pond should not be kept full during flood season. The "flood season" was not defined. There is neither any indication that the policy was adopted nor any written operational tool for establishing the level of the two ponds.

b. Warning System. There is no system either to warn of an impending flood or to warn of possible overtopping.

4.2 Maintenance Procedures

a. General. There is no set program for maintaining the dam. Maintenance is performed on an "as-needed" basis. The only operating facilities on the dam are the two sluice gates. At the time of the inspection, the timber stems for both gates were deteriorated and showed signs of rot. There is no established procedure for maintaining these facilities.

4.3 Evaluation

There is a possibility of a serious problem at the downstream end of the spillway. Just beyond the vertical face there is an enormous mat of trees, branches, general trash, and other debris which has accumulated downstream of the spillway. Spillway flows impinge upon this debris and are scattered sideways, possibly causing an undermining of the downstream foundation. There is no written procedure for clearing the debris from the base of the spillway although it was reportedly a regular problem. The general operational and maintenance procedures can be described as poor. The rotten gate stems, the debris at the base of the spillway and the trees growing on the downstream area are indications of neglect.

Current procedures are considered to be inadequate to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish written procedures for operating and maintaining the structure.

3.2 Evaluation

On the basis of the visual inspection, the dam is judged to be in fair condition. The following features if left unattended could result in the deterioration of the dam:

a. Erosion of soil and resulting undermining of the downstream walls next to the spillways can endanger the stability of the walls. The erosion is probably worsened by the debris accumulated downstream of the spillway which in part deflects the flow laterally.

b. A cavity produced by erosion of earth fill against the left spillway wall, if enlarged, can result in damage to the spillway floor and left wall which in turn could cause flow into the cavity and further erosion. Enlarging of the cavity will develop rapidly in case of overtopping of the dam.

c. The roots of trees growing at the crest next to the downstream wall can exert pressures against the downstream wall.

d. The condition of the downstream spillway wall and its foundation requires inspection after removal of the debris at the spillway discharge.

e. The scour or spalling of the spillway walls may indicate a serious problem with the original design of the spillway. The unusual throat configuration at the downstream end of the spillway may become the hydraulic control, thereby forcing a hydraulic jump in the middle of the spillway. The resulting roller could be the origination of the scour to the left of the spillway as shown in photo 6.

These walls do not reach the elevation of the crest (photo 7). The stone wall appears in good condidition and no evidence of seepage was observed in the wall. There are indications of minor lateral movement of the stone wall at mid-height. The concrete walls are also in good condition except for undermining that has occurred at the base of the concrete wall left of the spillway creating a void about 2 feet long and ½ inch deep. The concrete walls appear slightly bowed at mid-height. A seam observed at mid-height in the left concrete wall (Photo 8) may be the result of movement of concrete forms during initial construction. A masonry patch has been applied to the seam on the downstream face of the wall. Some efflorescence was also observed on the downstream face (Photo 9). There is some trespassing right of the spillway which has caused some deterioration of the downstream wall. The right bank downstream of the dam has an accumulation of debris. (photo 10).

There is a wet area about 20 ft. downstream of the dam, left of the spillway (photo 1). No water flow was evident.

c. Appurtenant Structures The spillway walls and floor appear in good condition (photo 11) with some apparent spalling of the floor near the downstream end, (photo 12) Minor cracks in the spillway walls are typical of the cracks caused by concrete shrinkage (photo 13). The downstream face of the spillway could not be observed due to a large amount of debris accumulated against it (photo 14). An undesirable effect of the accumulated debris is a lateral deflection of the water flow resulting in erosion of the banks of the downstream channel adjacent to the dam. The erosion is evident on the left back of the downstream channel (photo 14) where the stump of a tree has rotated about 90°. This erosion could be responsible for the undermining of the concrete wall, as discussed in the previous section. Due to the debris accumulation, it was not possible to observe the condition of the downstream wall of spillway and of the downstream channel bottom immediately downstream for evidences of scour (photo 15).

The gate mechanism for a low-level outlet (photo 16) is a pair of wooden vertical elements which have deteriorated and require replacement. The gate mechanism would not be accesible during floods. The outlet conduit could not be observed due to the debris at the downstream end.

d. Reservoir Area. There were no evidences of instability along the reservoir edge in the vicinity of the dam.

e. Downstream Channel. The downstream channel is the natural streambed. A small timber bridge for a logging road about 100 feet downstream of the dam would not present a significant obstruction to the flow. There is an abandoned dam, approximately 5 feet high, located about 100 yards downstream. The structure has been breached from the streambed to the right bank. Consequently it was not considered a significant obstruction to flow. These are a few overhanging trees along the downstream channel (Photo 15).

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Nichols Pond Dam was performed on October 25 and 26, 1979. The weather was cloudy and cold with temperatures near 32°F. The inspection team included personnel from DuBois & King, Inc.; Geotechnical Engineers Inc.; Knight Consulting Engineers, Inc.; and a representative of the Village of Hardwick. A copy of the inspection checklist as completed during the field inspection is included as Appendix A. At the time of the inspection, the water was at full pool and flowing over the spillway. Consequently, no assessment could be made of the upstream face of the structure.

b. Dam. The dam consists of an earthen embankment with a dry masonry downstream face (photo 1) and a concrete upstream face (photo 2). The upstream face of the dam is a vertical concrete wall (photo 3). A new wall has been built immediately upstream of the original wall. The exposed part of the new wall appears in good condition with only minor spalling and cracking, while the old wall shows severe spalling in its exposed upper part (photo [illegible]). The old wall appears to have settled slightly, on the right side of the spillway. The new wall does not show evidence of settlement.

The crest of the dam is grass covered with the exception of an area near the right abutment which is used for parking. Near the left abutment and also along the downstream edge, there are trees growing on the crest (photo 2). The elevation of the crest is somewhat irregular with areas higher and lower than the elevation of the top of the spillway walls. Adjacent to the left spillway wall there is a cavity about 3 to 4 ft. deep (photo 6). Further downstream along the left spillway wall, there is another cavity against the downstream wall (photo 5). It is possible that the two cavities are connected and may have formed when the dam has been overtopped and water has flowed into the upstream cavity and then downwards between the downstream wall and earth fill.

The downstream face of the dam consist of a dry masonry stone wall (photo 1) and concrete walls next to the spillway.

SECTION 2
ENGINEERING DATA

2.1 Design

Information on the design as well as specifications were not available for Nichols Pond Dam. The field sketch for this dam shows observable dimensions only.

2.2 Construction Data

Reports and records of construction were not available.

2.3 Operation

No operating manual was available for Nichols Pond Dam. Operating personnel reported that the facilities were operated annually to effect flow augmentation for hydro-power. There is no known schedule for monitoring the structure. There are records of past inspections performed by the Vermont Department of Water Resources and the Public Service Commission. These reports were valuable since they supplied additional dimensions which were unavailable at the time of the visual inspection.

2.4 Evaluation

a. Availability. The available information is not sufficient for stability analyses of the dam or the appurtenant structures. The only background data which could be located consisted of inspection reports by the Public Service Board and the Department of Water Resources of the state of Vermont.

b. Adequacy. The lack of engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data. All assessments were based primarily on the visual inspection, records of past performance, and sound hydrologic and structural engineering judgment.

c. Validity. Not applicable.

f. Reservoir Surface (acres).

1. Normal Pool	162
2. Flood-Control Pool	N/A
3. Spillway Crest	162
4. Test Flood Pool	182
5. Top of Dam	167

g. Dam

1. Type	earth and masonry structure
2. Length	approximately 200 feet
3. Height	approximately 18 feet
4. Top Width	30 feet (varies)
5. Side Slopes	Vertical
6. Zoning	N/A
7. Impervious Core	N/A
8. Cut-Off	Unknown
9. Grout Curtain	Unknown
10. Other	N/A

h. Diverson and Regulating Tunnel. Not Applicable.

i. Spillway.

1. Type	Concrete overflow in center of dam
2. Length of Weir	Varies from 37 feet to 7.25 feet
3. Crest Elevation	Varies from 1127.5 to 1126.0
4. Gates	N/A
5. Upstream Channel	N/A
6. Downstream Channel	Natural river bed

j. Regulating Outlets. Two sluice gates are located in the center of the dam. Reportedly, the outlet conduit is a 2 ft by 5 ft rectangular sluice. The gates are hand operated through a ratchet mechanism located in center of the principal spillway.

(4) Spillway Capacity at Test Flood Elevation. The capacity of the spillway at test flood (elevation 1135.5 NGVD) is approximately 600 cfs. This represents approximately 10% of the routed test flood outflow.

(5) Total Project Discharge at Top of Dam. At the top of the dam, the project will discharge 218 cfs at elevation 1130.5.

(6) Total Project Discharge for Test Flood Elevation. The total project will discharge 5,870 cfs at 1135.5 elevation.

c. Elevation (NGVD)

1.	Stream Bed at Toe of Dam	1110 ±
2.	Bottom of Cut-off	Unknown
3.	Maximum Tailwater	Unknown
4.	Recreation Pool	1127.5
5.	Full Flood Control Pool	N/A
6.	Spillway Crest (Ungated)	1127.5
7.	Design Surcharge (Original Design)	Unknown
8.	Top of Dam	1130.5
9.	Test Flood Design Surcharge	1135.5

d. Reservoir (length in feet). Nichols Pond is approximately circular in plan, and it is 3,700 feet from the dam to the inflowing stream at normal pool. At the test flood elevation (1135.5) the pond would be about 5,000 feet long.

e. Storage (acre-feet).

1.	Normal Pool	2590
2.	Flood Control Pool	N/A
3.	Spillway Crest Pool	2590
4.	Top of Dam	2841
5.	Test Flood Pool	3925

h. Design and Construction History. The history of the design and construction of Nichols Pond Dam is not available. It was reportedly constructed circa 1900.

i. Normal Operating Procedure. Nichols Pond Dam is maintained for flow augmentation for a power dam on the Lamoille River. The gates are reportedly opened in mid-summer and the pond level is maintained at approximately the spillway level (1127.5 NGVD). The gates are then closed in the spring to raise the pool level above the spillway level.

1.3 Pertinent Data

a. Drainage Area. The drainage basin of Nichols Pond Dam includes an area of 4.6 square miles. The land is mostly forested and the terrain is extremely steep and mountainous. One-half mile upstream along Nichols Brook, lies East Long Pond Dam which controls 3.5 square miles of the watershed. The basin is sparsely populated and there are very few houses and practically no paved roads.

The maximum reservoir area of 167 acres represents approximately 6% of the total drainage area. The predominant soils in the watershed are Glover-Calais and Calais-Buckland.

b. Discharge at the Dam Site.

(1) Outlet Works. Two sluice gates are located in the center of the structure. The gate operating mechanism consists of a timber riser attached to a ratchet system which is operated by a large wrench. In order to operate the gate mechanism, the operator has to stand in the center of the spillway. Consequently, the gates could not be operated during flood flows. Reportedly, the outlet conduit is a 2 ft by 5 ft rectangular sluice located in the center of the dam. The inlet of the sluice is located approximately 13.5 feet below the top of the dam.

(2) Maximum Known Flood. There were no records available nor were there any witnesses of any past flooding at the site.

(3) Spillway Capacity at Top of Dam. The principal spillway is a 37-foot wide structure which is notched approximately in the center. At the upstream end of the spillway, the notch is six inches deep and nine feet wide. At the downstream end of the spillway, the notch is four feet deep and 7 foot 3 inches wide. Above 100 cfs it is considered that this downstream throat would provide control by critical depth. This is the only uncontrolled outflow for the structure and its capacity at the top of the dam elevation 1130.5 is approximately 218 cfs (3.7% of the routed test flood outflow).

The upstream face has been capped with two layers of concrete. The downstream face is a dry-stone masonry wall in some places and there has been concrete facing applied to a certain area in the center of this structure. The dam itself is bisected by a concrete spillway which varies in width from 37 feet at the upstream end to 7 feet 3 inches at the downstream end. The spillway varies in depth from 1.5 feet at the upstream end to 4 feet at the downstream end. The crest of the dam varies in elevation between 1130 feet above mean sea level to 1131 feet above mean sea level. The lowest point in the spillway is at elevation 1127.5. The inlet invert of the sluice is approximately at elevation 1117.0 NGVD.

There is neither any emergency spillway nor any other provision for discharging flood flows.

c. Size Classification. Nichols Pond Dam is 18 feet high and has a storage capacity of 2840 acre-feet. In accordance with article 2.1.1 of the Recommended Guidelines for Safety Inspection of Dams, the dam is Intermediate in size based upon its storage capacity which is greater than 1000 acre-feet and less than 50,000 acre-feet.

d. Hazard Classification. The dam has a hazard classification of High based upon its potential for damage. Approximately 2 miles downstream lies Mackville Dam. The flood wave generated by a breach of Nichols Pond Dam with a water level at the top of the dam would be approximately 11.4 feet high when it reached the Mackville Dam Pond. It is considered that the flood wave generated by a breach of Nichols Pond Dam would cause subsequent overtopping of Mackville Dam. Appreciable damage could occur to five dwellings located at Mackville with flood levels up to five feet above the first floor of some of those dwellings. Another residential area one-half mile further downstream than Mackville has about ten more residences that would be subject to the resultant flood by an 11.6-foot-high wave. The outskirts of the Village of Hardwick would be subjected to a flood wave 6.8 feet high. It is possible that more than a few lives may be lost if Nichols Pond Dam is breached.

e. Ownership. This dam is owned by the Village of Hardwick Electric Light Department. The dam was originally owned by Woodbury Granite Company and then by Green Mountain Power Corporation before it was acquired by its present owner.

f. Operator. The dam is operated and maintained by the Village of Hardwick, Vermont 05843. Mr. William Fee, Village Manager, is in charge of all Village equipment. His telephone number is 802/472-5201.

g. Purpose. The original purpose of the dam was to provide water supply to operate Mackville Dam for power generation. The power generating facilities of Mackville Dam have been eliminated; however, the outflow from Nichols Pond Dam is used to augment the flows for another dam on the Lamoille River at Pottersville which generates power for the Village of Hardwick Electric Light Department.

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
NICHOLS POND DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. DuBois & King, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Vermont. Authorization and notice to proceed were issued to DuBois & King, Inc., under a letter of October 19, 1979 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0003 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

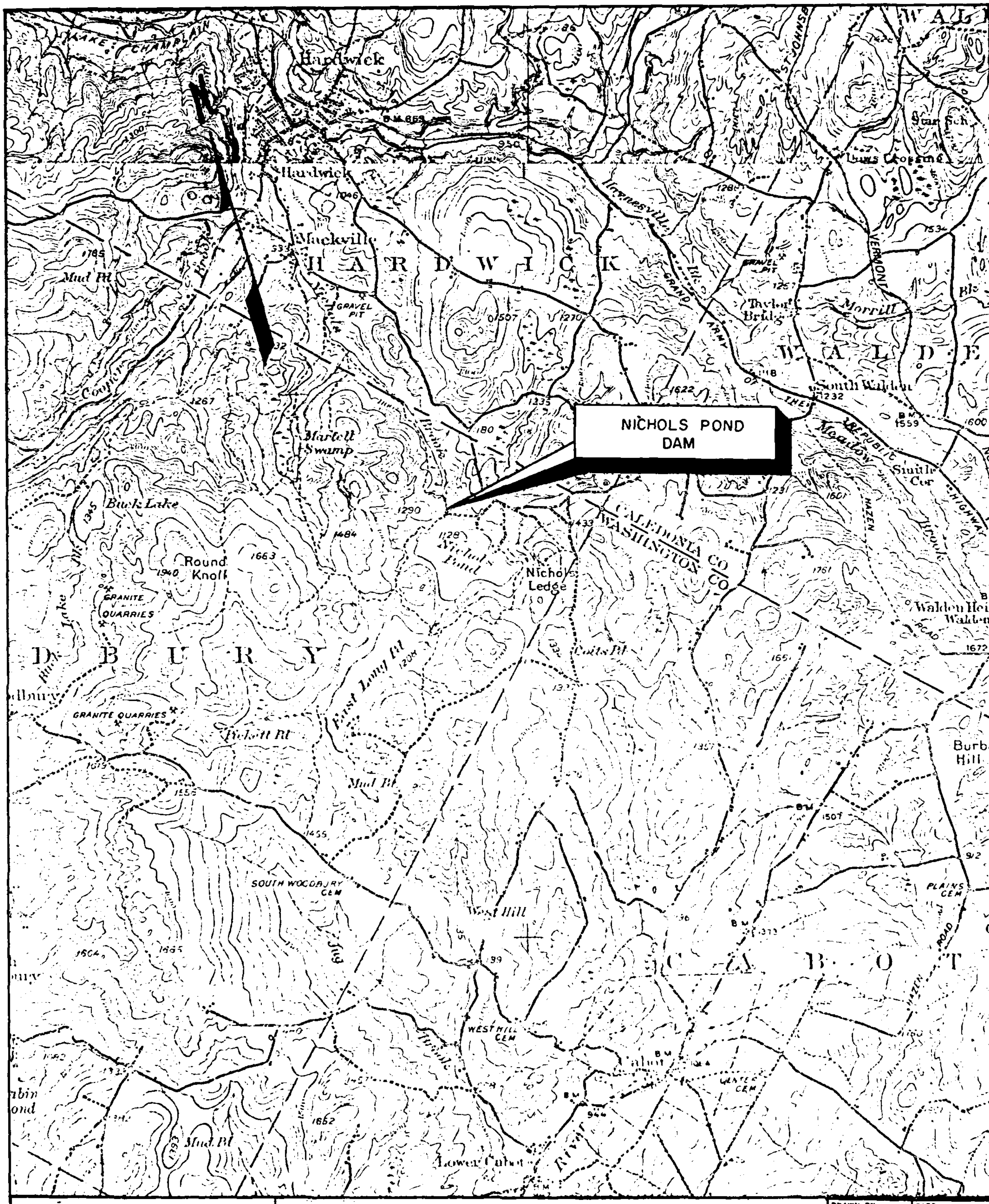
(2) To encourage and prepare the states to quickly initiate effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Nichols Pond Dam is located in the Town of Woodbury, Vermont on Nichols Brook approximately three miles upstream from its confluence with Cooper Brook. The dam is shown on the 15 minute U.S.G.S. Quadrangle for Plainfield, Vermont, with coordinates approximately 72° 20.6' west longitude, 44° 27.7' north latitude, Washington County, Vermont. The location of Nichols Dam is shown on the location map immediately preceding this page.

b. Description of Dam and Appurtenances. Nichols Pond Dam is an earth and masonry structure approximately 18 feet high with vertical walls both upstream and downstream. The breadth of the structure varies from 28 to 44 feet with an average breadth of approximately 30 feet.



DuBois & King inc.
engineering and environmental services
RANDOLPH, VERMONT CONCORD, NEW HAMPSHIRE

NATIONAL DAM INSPECTION PROGRAM

NICHOLS POND DAM

LOCATION MAP

USGS QUAD - PLAINFIELD, VERMONT

DRAWN BY JAS	DATE 12/79
CHECKED BY RMC	PROJ NO. 91118
PROJ ENG	DRAW NO

SCALE: 1" = 62500'

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicated the dam to be generally in fair condition. Items that could result in deterioration of this condition are:

- Erosion of soil downstream of dam, next to spillway, and resulting undermining of the downstream wall of the dam.
- A cavity at the crest, next to the left spillway wall.
- Trees growing next to the downstream wall.
- The timber risers that serve as gate stems are badly deteriorated.
- No emergency spillway.
- Scouring and spalling of the spillway.

The assessment of the present condition of the dam is subject to verification by inspection of the downstream wall of the spillway which could not be observed due to accumulation of debris.

b. Adequacy of Information. The information available was practically nil and thus the assessment of the condition of the dam is based solely on the visual inspection.

c. Urgency. The recommendations presented in Section 7.2 and 7.3 should be carried out within one year of receipt of this report by the owner.

7.2 Recommendations

The following investigations and needed corrections should be performed under the direction of a registered engineer qualified in the design and construction of dams.

Removal of debris that has accumulated downstream of the spillway and examination of the downstream spillway wall and its foundation for scour and possible undermining, and design of any repairs which might be needed.

Design measures to prevent accumulation of debris at the spillway discharge. This may include the design and ininstallation of a log boom across the intake channel.

Design an appurtenant structure for the base of the spillway to prevent erosion of banks immediately downstream of the spillway. This may include an additional structure such as a "plunge pool" or a re-regulating weir to provide backwater.

Hydraulic analysis of the spillway to determine whether or not a hydraulic jump will form within the confines of the spillway. This may precipitate the redesign of the spillway structure to eliminate this undesirable occurrence.

Hydrologic and economic evaluation of the installation of an emergency spillway of sufficient capacity to protect the safety of the dam. This may include the raising of the structure to safely pass a design flood.

Replacement of deteriorated timber stems and a thorough examination of the gates and trash rack.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

1. Remove trees and bushes growing on the crest and overhanging the downstream channel.

2. Fill the cavity next to the spillway left wall with lean concrete or compacted clayey soil.

3. Repair cracked and spalled concrete on the principal spillway.

4. Restrict trespassing from the crest of the structure.

5. Establish a program of annual technical inspections by a registered qualified engineer.

6. Develop a formal surveillance and downstream flood warning plan including round-the-clock monitoring during heavy precipitation.

7.4 Alternatives

There are no alternatives which are consistent with the present uses of the dam.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT NICHOLS POND

DATE 10-25-79

TIME P.M.

WEATHER COOL

W.S. ELEV. ______ U.S. ____ DN.S

PARTY:

1. John Bilotta D&K	6.
2. Jeffrey Spaulding D&K	7.
3. Gonzalo Castro GEI	8.
4. Stephen Knight KCE	9.
5. Erwin Gilcris Village of Hardwick	10.

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Structure	S. Knight	
2. Foundations	G. Castro	
3. Hydraulics/Electric Mechanical	J. Bilotta	
4.		
5.		
6.		
7.		
8.		
9.		
10		

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM

DATE 10-25/26-79

PROJECT FEATURE

NAME J. Bilotta

DISCIPLINE

NAME S. Knight KCE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
DAM ENBANKMENT	Earth with upstream vertical concrete face and downstream vertical stone face.
Crest Elevation	
Current Pool Elevation	1-inch over spillway crest.
Maximum Impoundment to Date	Unknown
Surface Cracks	A few cracks on upstream face.
Pavement Condition	N.A.
Movement or Settlement of Crest	Possible settlement of old upstream concrete face to right of spillway.
Lateral Movement	None observed.
Vertical Alignment	Crest very irregular.
Horizontal Alignment	Downstream stone wall bowed Downstream concrete bowed-likely due to defective form.
Condition at Abutment	Minor erosion at end of concrete wall at right abutment(u.s.)
Indications of Movement of Structural Items on Slopes	N.A.
Trespassing on Slopes	Downstream edge of crest right of spillway - footpath. Also logging road around right end which is at same elevation as dam.
Vegitation on Slopes	Some at earth slope near right abutment.
Sloughing or Erosion of Slopes or Abutments	Erosion of crest against left wall of spillway.
Rock Slope Protection - Riprap Failures	N.A.

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM

DATE 10-25/26-79

PROJECT FEATURE

NAME J. Bilotta D&K

NAME S. Knight KCE

DISCIPLINE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	None observable.
Slope Conditions	
Bottom Conditions	
Rock SLides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	Riser stems - vertical timbers that are used to raise gates are deteriorated

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM

DATE 10-25/26-79

PROJECT FEATURE

NAME J. Bilotta D&K

DISCIPLINE

NAME S. Knight KCE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	None as such.
A. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	None.
Float Wells	None.
Crane Hoist	None.
Elevator	None.
Hydraulic System	None.
Service Gates	Hand operated by a large wrench - we were told that it is operated at least annually not accessable when water flowing over spillway, wrench is kept at garage.
Emergency Gates	None.
Lighting Protection System	None.
Emergency Power System	None.
Wiring and Lighting System in Gate Chamber	None.

DAM EMBANKMENT CONTINUED	
Unusual Movement or Cracking at or near Toes	N.A. but there is a cavity under concrete wall left of spillway (0.5' x 2.0').
Embankment or Downstream Seepage	5' x 10' wet area 20'downstream of dam opposite stonewall on left of spillway.
Piping or Boils	None observed.
Foundation Drainage Features	None known.
Toe Drains	None known.
Instrumentation System	None known.

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM

DATE 10-25/26-79

PROJECT FEATURE

NAME J. Bilotta D&K

DISCIPLINE

NAME S. Knight KCE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Outlet of conduit not visible because of debris at discharge covering outlet completely.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of MOnoliths	

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM

DATE 10-25/26-79

PROJECT FEATURE

NAME J. Bilotta D&K

DISCIPLINE

NAME S. Knight KCE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	No outlet structure.
General Condition of Concrete	See spillway for condition of channel.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain joles	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM | DATE 10-25/26-79

PROJECT FEATURE | NAME J. Bilotta D&K

DISCIPLINE | NAME S. Knight KCE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Non visible.
General Condition	N.A.
Loose Rock Overhanging Channel	N.A.
Trees Overhanging Channel	N.A.
Floor of Approach Channel	N.A.
b. Weir and Traing Walls	
General Condition of Concrete	Good.
Rust or Staining	Minor staining.
Spalling	Concrete spall in bottom of spillway channel apparently due to cavitation.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	None observed.
Drain Holes	None observed.
c. Discharge Channel	
General Condition	Full of debris for 30' downstream of dam
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Yes, Several - some have fallen into channel.
Floor of Channel	Boulders
Other Obstructions	Logging road bridge at about 100' downstream

NOTE: Both banks of discharge channel severely eroded adjacent to dam.

INSPECTION CHECK LIST

PROJECT NICHOLS POND DAM

DATE 10-25/26-79

PROJECT FEATURE

NAME J. Bilotta D&K

DISCIPLINE

NAME S. Knight KCE

NAME G. Castro GEI

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	No service bridge.
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
Genral Condition of Conrete	
Alignment of Abutment	
Approach to Bridge	
Conditon of Seat & Backwall	

APPENDIX B

ENGINEERING DATA

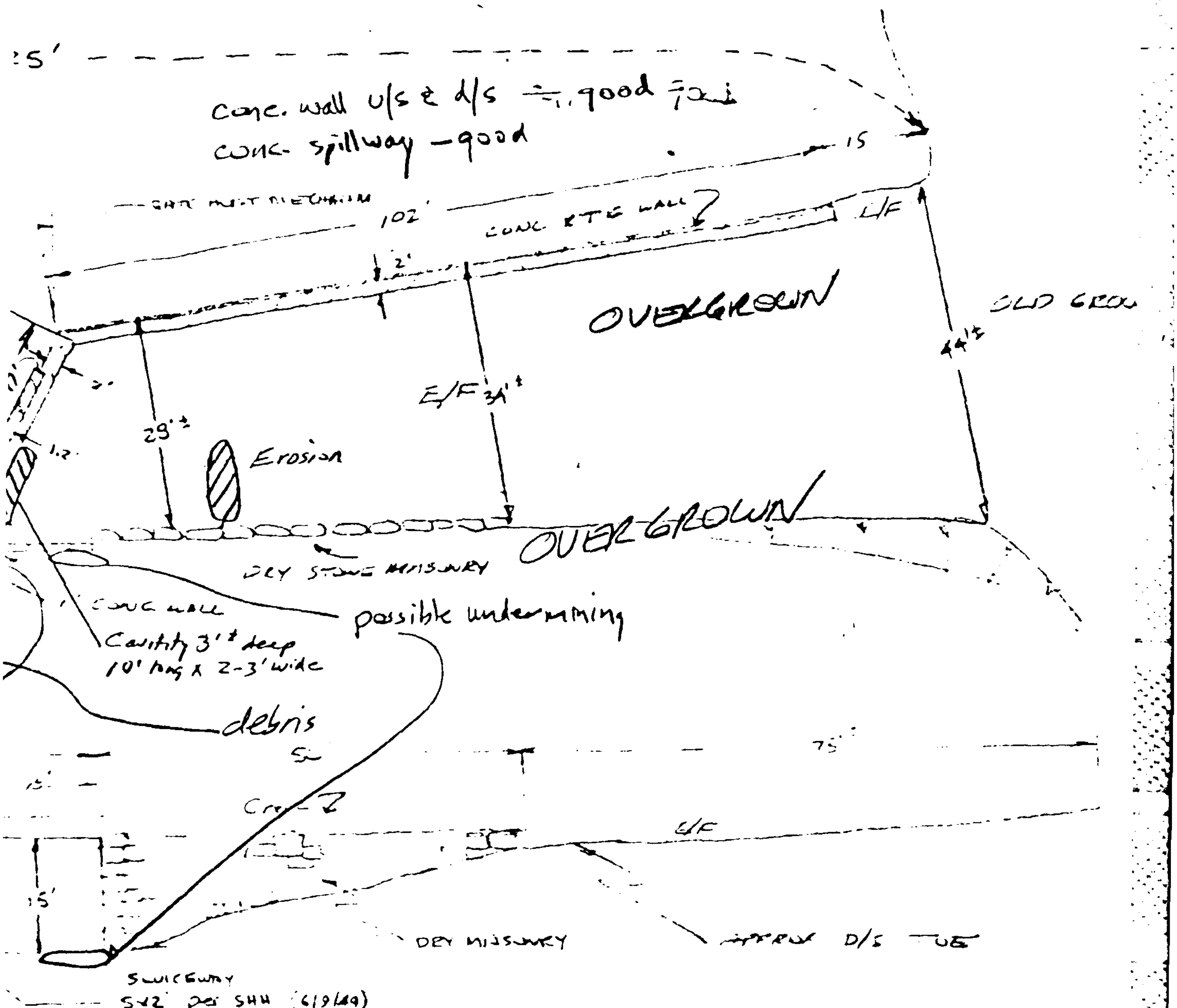
APPENDIX B

1. There are no known records of design, construction or maintenance.

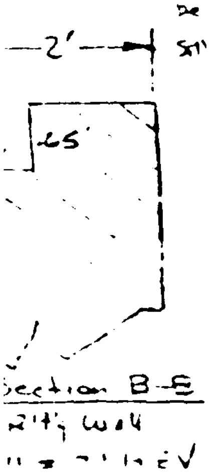
2. A copy of an inspection performed by Stephen Haybrook for the Public Service Commission can be found on pages B-2 through B-5. The inspection was dated October 26, 1949. A copy of an analysis performed in 1954 by Louis M. Laushey for the Public Service Commission appears on pages B-6 through B-11. A copy of an inspection performed in 1979 by A. Peter Baraanco for the Department of Water Resources can be found on pages B-12 through B-14. A letter report by Mr. Barranco describes some of the history on page B-15.

3. Plans and sketches prepared by DuBois & King, Inc., appear on figure B-1, page B-16. Information shown on these plans and sketches is based upon information in past inspection reports and observations made during the visual inspection. Dimensions or materials indicated at the time of inspection were not verified. Elevations shown are based upon USGS datum.

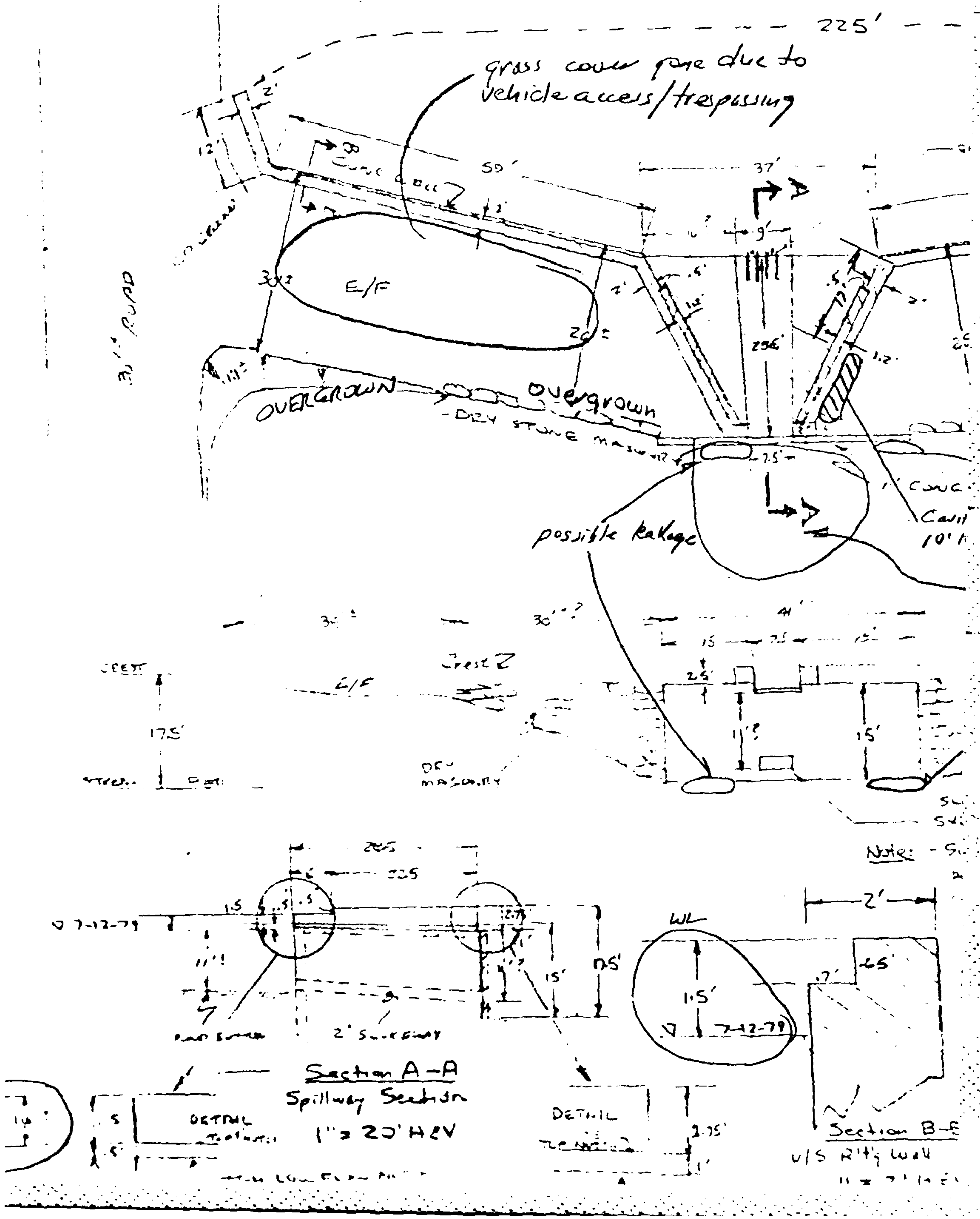
4. There are no known records of subsurface investigations.



Note: - Size and location of sluiceway could not be verified because of debris block d/s face
Sill of sluiceway appeared to be 11' below top of wall



Notes based on
Survey / Inspection 7-12-
Hot, Clear
Hand level, 6' rule & cloth


225'
grass cover gone due to vehicle access/trespassing
59'
37'
E/F
OVERGROWN
Overgrown
DRY STONE MASONRY
possible leakage
ROAD
CREST
17.5'
15'
Note:
Section A-A
Spillway Section
1" = 20' HZV
DETAIL
2' SURFSWAY
13.5'
15'
11.5'
WL
7-12-79
2'
6.5'
Section B-B
U/S R't Wall

STATE OF VERMONT

AGENCY OF ENVIRONMENTAL CONSERVATION

Montpelier, Vermont 05602
Department of Water Resources

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources
Environmental Board
Division of Environmental Engineering
Division of Environmental Protection
Natural Resources Conservation Council

WATER QUALITY DIVISION

October 12, 1979

M E M O R A N D U M

To: File

From: A. Peter Barranco, Jr., P.E., Dam Safety Engineer

Subject: Nichols Pond Dam - Woodbury (252-1)

The writer inspected subject dam, obtained dimensions and photographs on July 12, 1979.

Overall the dam appears to be in good condition but in need of brush and tree removal on crest and downstream slopes and debris removal below spillway.

The only items of some concern are two areas where erosion has occured. One is a cavity about 10' long, 2-3' wide and 3' deep adjacent to the left spillway wall. It could not be determined if this resulted from overtopping or from subsidence due to soil being removed internally. The downstream face was so packed with debris (logs and branches) that an examination of the downstream base of the wall was not possible. The other area is about 30' left of the spillway on the downstream side of the crest. Since there is only about 1.5' of freeboard at normal pool and a relatively small spillway that is subject to blockage by debris, overtopping of this dam would appear likely.

There may be some leakage and undermining below downstream wall, however, debris prevented a close examination. Concrete in spillway and walls in generally good condition. Water level was about 0.4' above crest of low flow notch, or about 1.5' below crest. Crest is somewhat irregular. Wood in gate stems may be nearing end of its useful life.

vl

DAM INSPECTION STATUS

Name Nichols Pond DWR No. 252-1
Town Woodbury NDS No. VT00 164
Owner Village of Hardwick (Electric Dept.) Hazard Class 2 *
Address Hardwick, Vt. Size Category II
Telephone 472-5201 (Supt. Village Elec. Dept.) Inspect every N/R years **

Type EF/Sil Height 18' Storage 1200 Use P(S) Juris. PSB

INSPECTION RECORD

** Not required. PSB jurisdiction. DWR inspects when in area on informal basis.

Inspection Date	Inspected By	Report Date	Owner Notified	Condition Summary
6-9-49	SHH (PSC)	10-26-49		Fair. Repairs/maint. needed. Inadequate spillway
5-9-53	SHH (PSC)	5-9-53		Fair-poor. Some deterioration since last inspection.
11-22-54	PSC + Consultant	11-26-54	12-1-54	Fair-poor. Repairs needed. Inadequate spillway at 1/;
7-27-73	DHS (DWR)	7-27-73		Good. No storm damage. Maint. needed.
7-12-79	APB (DWR)	10-12-79		Good. Erosion on crest. Brush & trees. Debris.

POTENTIAL DOWNSTREAM HAZARDS

Description	Miles Downstream	Remarks
Mackville Pond Dam	2.5	Subject to overtopping by Nichols Pond & E. Long Pd.
Mackville (village)	2.6-3.1	TH bridge, powerhouse, structures, trailers?
Route 14 (Hardwick)	3.1	Bridge

* Hazard Class 2 based on possible overtopping and failure of Mackville Pond Dam.

INFORMATION AVAILABLE

Plans ______ Dimensions (field check) 6-9-49 7-12-49 Photos 1979

INFORMATION NEEDED NEXT INSPECTION

Dimensions (field check) ______ Detailed Survey ______ Photos ✓
Other ______

DWR 1/79

can handle floods safely. The rate of 800 cubic feet per second discharged from East Long Pond will be reduced some by channel storage, and Nichols Dam might possibly have to discharge 600 cubic feet per second plus the estimated 200 to 320 cubic feet per second from its own watershed. The sum would be of the order of magnitude of not more than 1000 cubic feet per second--which it could not do safely with its estimated capacity of not more than one-half this amount.

Some of these figures were estimated simply to get an approximate answer. With more complete information on the nature of the one-half mile long connecting stream and the reservoir characteristics at East Long Pond, more detailed calculations could give a more exact answer. However, it seems clear that the outflow capacity at Nichols Dam is adequate as long as both reservoirs are not full at the same time; under these latter circumstances the Nichols outflow capacity(spillway and sluice) would be about fifty percent adequate to handle a major flood on both areas.

Recommendations.-

1. Repair head wall, spillway slab and wall, and earth embankment as described previously.

2. Definitely avoid having both reservoirs full at the same time during seasons when heavy runoffs can be expected.

Louis M. Laushey

Louis M. Laushey
Professional Engineer

Fanning, for New England streams(maximum flow)

$$Q = 200(1)^{5/6} \doteq 200 \text{ cubic feet per second}$$

Rational Formula (2" rain per hour, 25% runoff)

$$Q = (0.25)\ (2)\ (640) = 320 \text{ cubic feet per sec.}$$

All of these empirical formulas show rates less than the estimated 485 cubic feet per second capacity available. Although there have been many instances of much higher run-off rates from a one square mile area, because the area is forested it is believed that the discharge capacity of Nichols Dam is sufficient if inflows from East Long Pond are small or non-existent during a heavy storm and "full" reservoir at Nichols Pond.

Condition "b" above.

When both reservoirs are in flood simultaneously the discharge capacity at Nichols Dam can be estimated as follows: add to the flow from the Nichols watershed the estimated inflow rate minus the effect of storage.

From the previous calculations of the flood rates, corrected for the new drainage area of 3 square miles, it is likely that a peak flow between 500 and 1000 cubic feet per second can enter the East Long Pond reservoir. Information is lacking on storage capacity, but it can be estimated that say 800 cubic feet per second could be discharged. Although complete information is lacking, it is known that the sluice capacity alone is about three times that at Nichols Dam, and assuming the spillway is of the same order of relative magnitude, it appears likely that East Long Pond

Sluice Capacity: - The approximate sluice capacity is

$$Q = (5x2)(8.02)\sqrt{\frac{(12-1)+5}{1+0.5+\left\{0.02 \times \frac{40}{4\left(\frac{10}{14}\right)}\right\}}}$$

Q = 240 cubic feet per second

Combined Capacity: - The combined capacity of sluice and spillway. (at a head above the crest of 1.5 feet) is 240 + 245 = 485 cubic feet per second. This should be sufficient to handle the drainage from a severe storm on the one square mile watershed - assuming no inflow from the East Long Pond Dam.

Inflow from East Long Pond Dam: - The required discharge capacity of Nichols Dam will be computed for two conditions which depend on the method of operation of the reservoir and the extent of the storm.

(a) no inflow from East Long Pond Dam, but "full" reservoir in Nichols Dam during a storm on the Nichols Dam Watershed only.

(b) inflow from East Long Pond Dam assuming both reservoirs"full"and a storm over both watersheds. This is of course, the most serious possibility.

Required Capacity: -

Condition "a" above - Nichols Dam should have a combined spillway and sluice capacity within the following limits to handle safely runoff from it's own watershed only.

Kuichling (for frequent floods)

$$Q = \left[\frac{44,000}{1+370} + 20\right] 1.0 = \underline{138} \text{ cubic feet per second}$$

The Embankment: - The embankment is well-sodded and quite stable. The downstream face is in good condition; no leakage was observed, although the pond level was low and leakage might occur through the disintegrated wall during high water.

Minor repairs are needed on a small section of the right bank beyond the head wall to fill and stabilize this section which has eroded out. The damage is not serious, but should be rectified when the head wall is repaired.

The Spillway: - The 6-inch thick spillway slab and the spillway guide walls are cracked in several places, probably due to settlement of the slab on the earth fill under the slabs. The bituminous filler previously used to attempt repairs is not effective, and leakage might occur through the cracks into the earth fill under the slab. The rock face which retains the earth fill on the downstream side of the spillway is in good condition.

The spillway slab and guide walls should be patched with new concrete to prevent leakage into the earth fill under the spillway slab when the spillway is in operation.

The Spillway Capacity: - The maximum safe capacity of the spillway is estimated to be:

$$Q = 3.7 \times 36(1.5)^{3/2} = 245 \text{ cubic feet per second}$$

[illegible] control!

feet.

The non-overflow section of the Nichols Pond Dam is an earth embankment with these approximate dimensions: length, 160 feet, width 26 feet, and height 14 feet. A concrete head wall, 12 inches wide extends the length of the embankment on the upstream side. The spillway is nearly in the center of the embankment, being 36 feet long at the crest, and capable of a maximum safe head of 1.5 feet. A rectangular sluice, 5 feet x 2 feet, controlled by 2 hand operated gates, also passes water downstream along the longitudinal center-line of the spillway.

The Head Wall: - The 12-inch wide concrete head wall is badly spalled and disintegrated. A bituminous joint sealer applied years ago to seal the cracks in the wall is not now effective. It is expected that leakage would occur when the pond is high, although none was noticed during the inspection because the pond was several feet below the spillway crest, and most of the serious disintegration was at a higher elevation. The stability of the dam is not affected by the disintegrated wall as long as leakage does not occur.

The head wall should be resurfaced by chipping out all unsound sections and replacing with new concrete adequately tied into the sound portion of the existing wall. This would not be a major project because most of the disintegration is at a high elevation.

[illegible]
Hardwick Village

Winch Hill Road
Northfield, Vermont
November 26, 1954

Mr. Oscar L. Shepard
Chairman, State of Vermont
Public Service Commission
Montpelier, Vermont

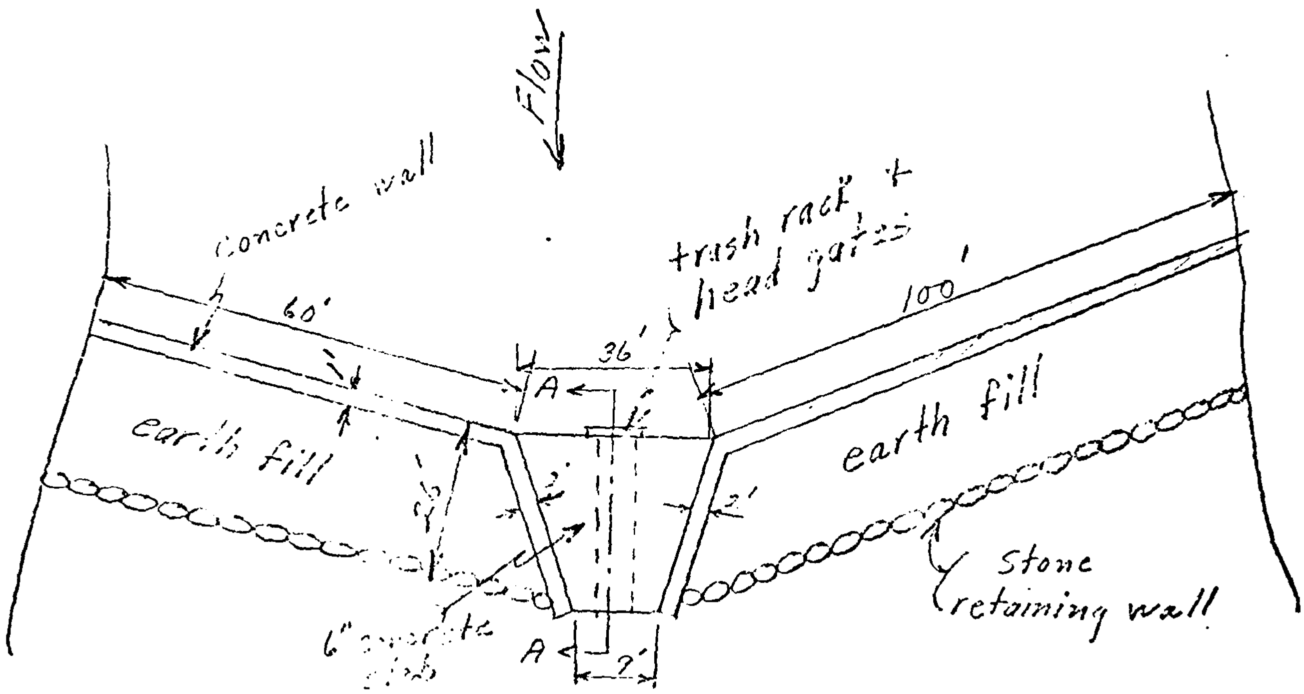
Subject: Nichols Pond Dam

Dear Mr. Shepard:

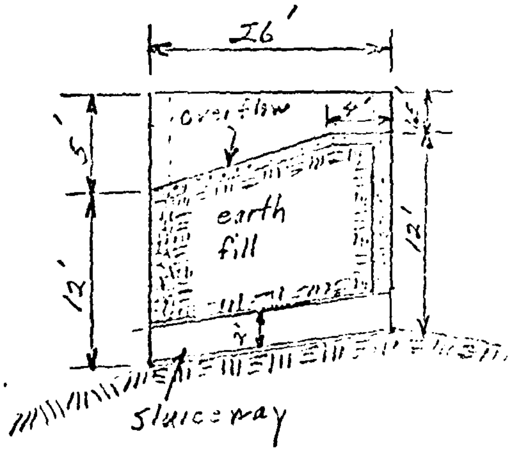
Nichols Pond Dam was inspected on November 22, 1954 in accordance with the policy of the Vermont Public Service Commission to periodically check on the safety of the dams in the state. The inspection party consisted of Mr. Silas C. Carpenter, Engineer for the Public Service Commission, Mr. Larrabee, Superintendent for the Village of Hardwick, and the writer.

The owner and operator of the Nichols Pond Dam is the Village of Hardwick, Vermont. The dam is located near Woodbury, Vermont which is downstream from the dam. East Long Pond Dam and Reservoir are approximately one-half mile upstream from the Nichols Pond Dam.

Nichols Pond Dam forms a lake of approximately 125 acres, with a storage of approximately 54 million cubic feet. The drainage area is about 1 square mile. The East Long Pond overflow also discharges into the Nichols Pond. The drainage area above East Long Pond is approximately 3 square miles; the pond has an approximate area of 250 acres and storage of 43 million cubic



Plan View



Section A-A

Sketch of
Nichols' Pond Dam

Drawn by SHH
6/9/49

Conclusions:

The writer concludes that this dam is in a satisfactory structural condition but lacks adequate spillway capacity. Keeping one or both ponds below spillway crest level provides a margin of safety against overtopping and probable destruction of the dam. If, at some future time, it becomes desirable to maintain a full pond level at both Nichols Pond and East Long Pond, then consideration should be given to enlarging the spillway capacity.

Stephen H. Haybrook
STEPHEN H. HAYBROOK
HYDRAULIC ENGINEER

Public Service Commission
Montpelier, Vermont
October 26, 1949

Report No. 79

through seepage. Although the wall appeared in a weakened condition, it was considered stable enough to retain the embankment.

On date of visit the pond level was drawn down to about 5 ft. below crest level. With this low water it was impossible to determine what seepage, if any, occurred through the dam.

The embankment was well consolidated and sufficiently contained between its outside walls. Its top was protected by a sod cover. Both sluice gates were in good working order. The outlet and overflow structures were in good condition.

From all appearances the dam was being provided with the usual maintenance.

Comments re Dam:

At this dam the spillway capacity is limited. With both Nichols Pond and East Long Pond full at a time of maximum flood inflow, the spillway could not handle, simultaneously, the runoff from its own drainage area and the overflow from East Long Pond.

According to the operator, both ponds are never full at the same time. Either one or the other is generally drawn down below crest-level. With this method of operation, the possibility of overtopping Nichols Pond dam is greatly reduced.

It will be noted that both ponds are located in an isolated, wooded section. Consequently, the possibility of flood damage is also reduced.

Wm. Mac. : Elliott
[illegible] Brown

REPORT ON NICHOLS POND DAM

Supplementing the storage of East Long Pond is Nichols Pond about 1/2 mile further downstream and on the same brook in the town of Woodbury, Vermont. This storage is used according to the needs of the owner's hydro-electric plant in the course of the stream. It is owned and operated by the Village of Hardwick.

The dam at the outlet creates a pond having a surface area of about 125 acres and a useable volume estimated at 54 million cubic feet. Besides the discharge from East Long Pond it receives the drainage from a catchment area of 1 square mile.

Description of Dam:

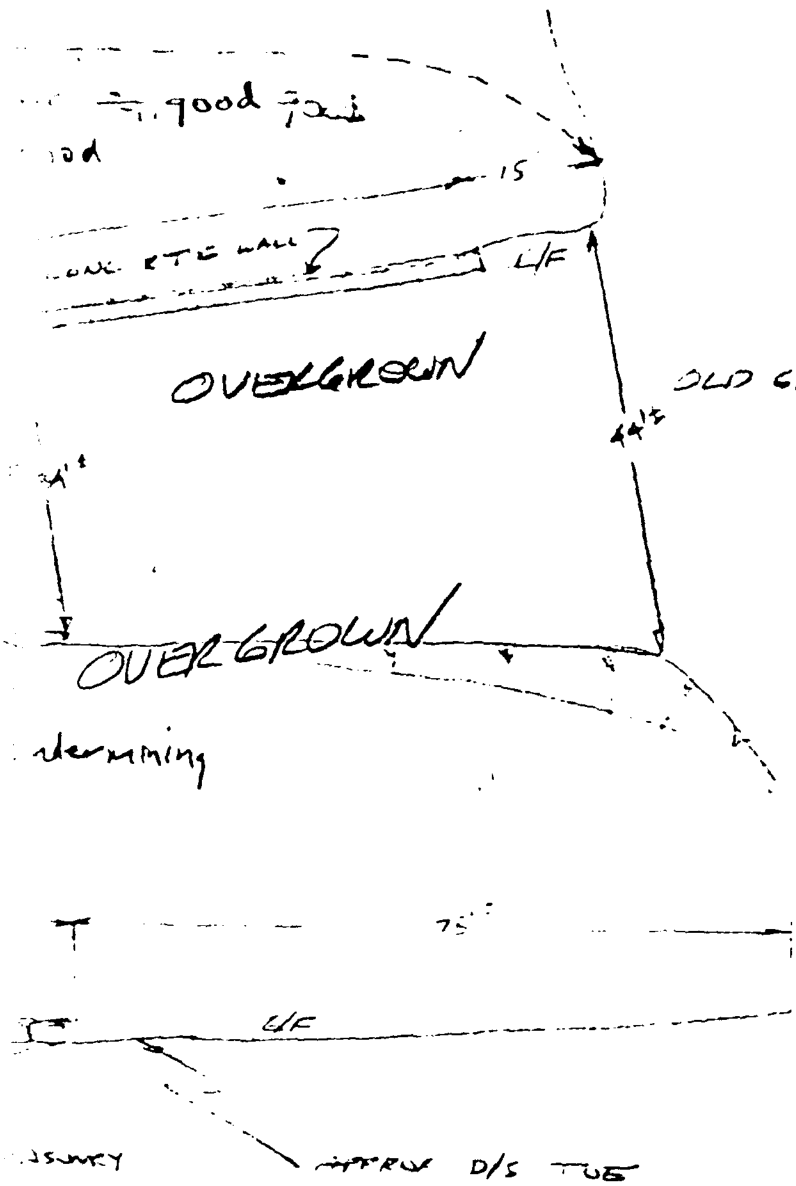
In general, the dam consists of an earth-fill contained between a concrete wall on the upstream side and a dry stone masonry wall on the downstream side. It is about 200 ft. in total length, 26 ft. in width and 14 ft. in height. A sketch of the dam is appended herein.

Discharge past the dam is provided by a rectangular concrete sluiceway, 5 ft. by 2 ft., and controlled by two hand operated wooden gates. Overflow is accommodated by a concrete-paved spillway trough 1.5 ft. below the top of the dam and located through its middle.

Notes from Inspection of June 9, 1949:

The concrete head wall making up the upstream face of the dam showed a battered effect due to wave and ice action. A bituminous material has been applied to the cracks to control

3



~~~wio rk
~~k d/s face
~ 11' below top of wall

Notes based on
Survey / Inspection 7-12-79 APB
Hot, Clear
Hand level, 6' rule & cloth tape
~~~

STATE OF VERMONT

AGENCY OF ENVIRONMENTAL CONSERVATION

Montpelier, Vermont 05602
Department of Water Resources

Department of Fish and Game
Department of Forests, Parks, and Recreation
Department of Water Resources
Environmental Board
Division of Environmental Engineering
Division of Environmental Protection
Natural Resources Conservation Council

WATER QUALITY DIVISION

October 16, 1979

M E M O R A N D U M

To: File

From: A. Peter Barranco, Jr., P.E., Dam Safety Engineer

Subject: Mackville Pond Dam - Hardwick (93-2)

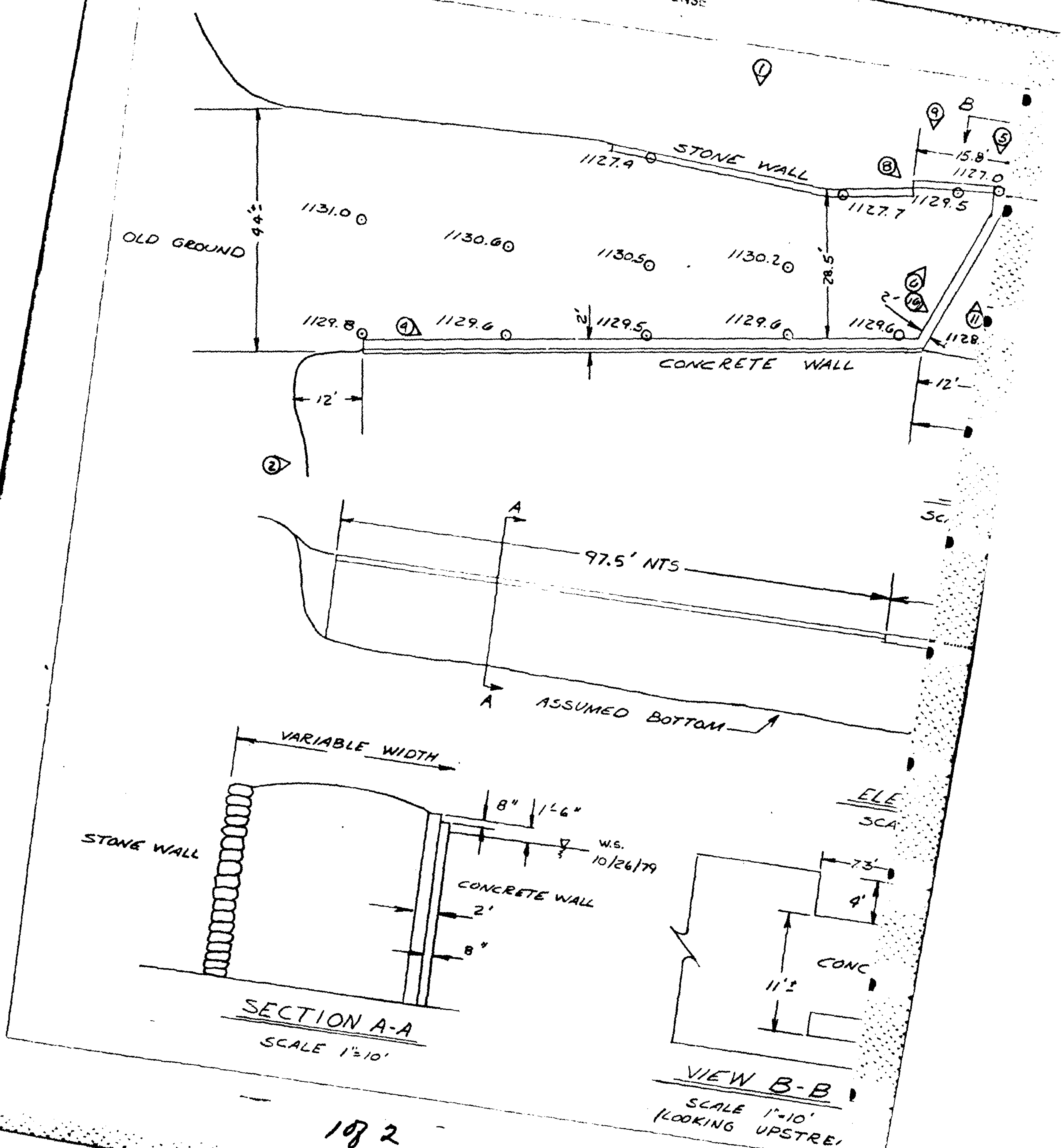
On July 12, 1979 the writer inspected subject structure and obtained photographs and additional dimensions.

The dam is in fair-poor condition, particularly because of lack of maintenance and repairs. Brush and tree growth made access and inspection difficult, however, despite its rundown condition the dam appears to be stable. The concrete training wall on the right downstream channel wall is in good condition. Leakage was noted along part of downstream face, however, it is about what one would expect of a dam of this construction and condition. Spillways are somewhat irregular due to loss of concrete cap and type of construction. Mortar on left upstream face has deteriorated.

While at the site, the writer spoke with Mr. Carroll Rowell who has lived in the house at the right end of the dam since 1913. Mr. Rowell is familiar with the history of this dam and the ones on Nichols Pond and East Long Pond - all of which were built by the Woodbury Granite Company. Mackville Pond Dam was apparently built about 1900. During the 1927 flood, the dam and bridge were overtopped but held, however, the right side of the pond (apparently old ground) washed out and destroyed several homes. The washout left a very deep ravine next to Mr. Rowell's house but did not damage the house because the erosion on that side was halted by ledge. After the flood, the washed out area and road were filled, however, the fill would not hold and it was necessary to drive steel sheet piling from near the right abutment across the town road a distance of 200-300' to hold it. The houses destroyed in the flood were not rebuilt.

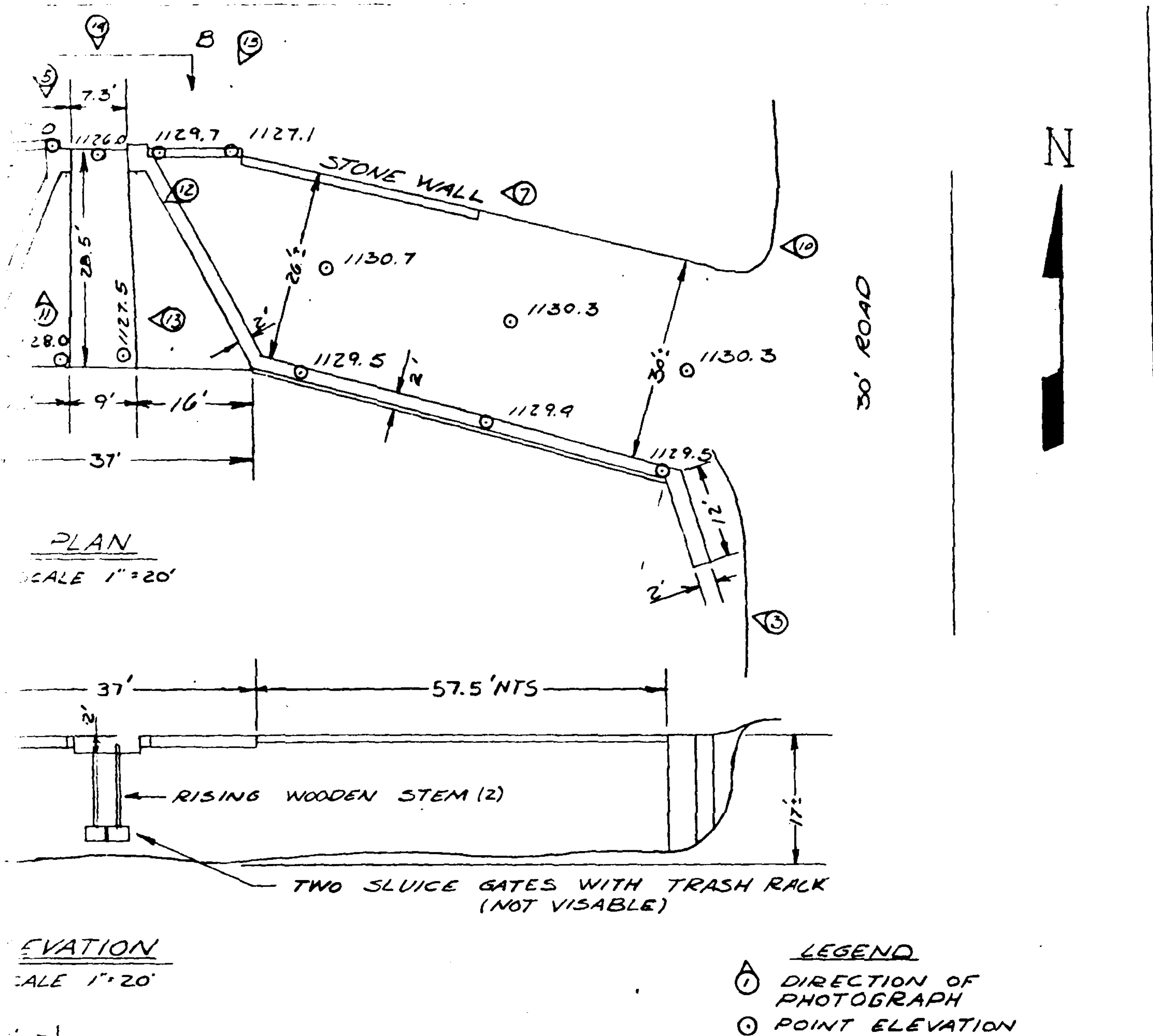
During the 1973 flood, according to high water marks pointed out by Mr. Rowell, the pond level rose to 3.5' above spillway crest which would mean that the "non-overflow" sections were overtopped by about a foot.

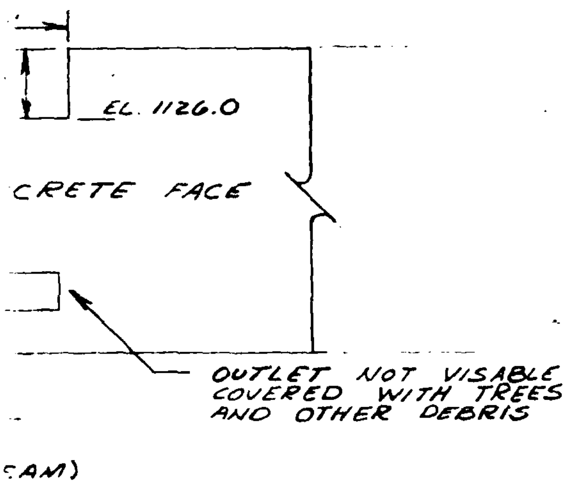
vl



SECTION A-A
SCALE 1"=10'

VIEW B-B
SCALE 1"=10'
(LOOKING UPSTRE





DuBois & King inc.
engineering and environmental services
RANDOLPH VERMONT / CONCORD NEW HAMPSHIRE

Department of the Army
New England Division
Corps of Engineers
Waltham, MA 02154

NATIONAL DAM INSPECTION PROGRAM

NICHOLS POND DAM
WOODBURY, VERMONT

PLAN AND ELEVATION VIEW

DRAWN	ENGR	PROJ. MGR	SCALE: AS SHOWN
JAS	AMC		DATE: DECEMBER 18, 197?

PLATE B-1

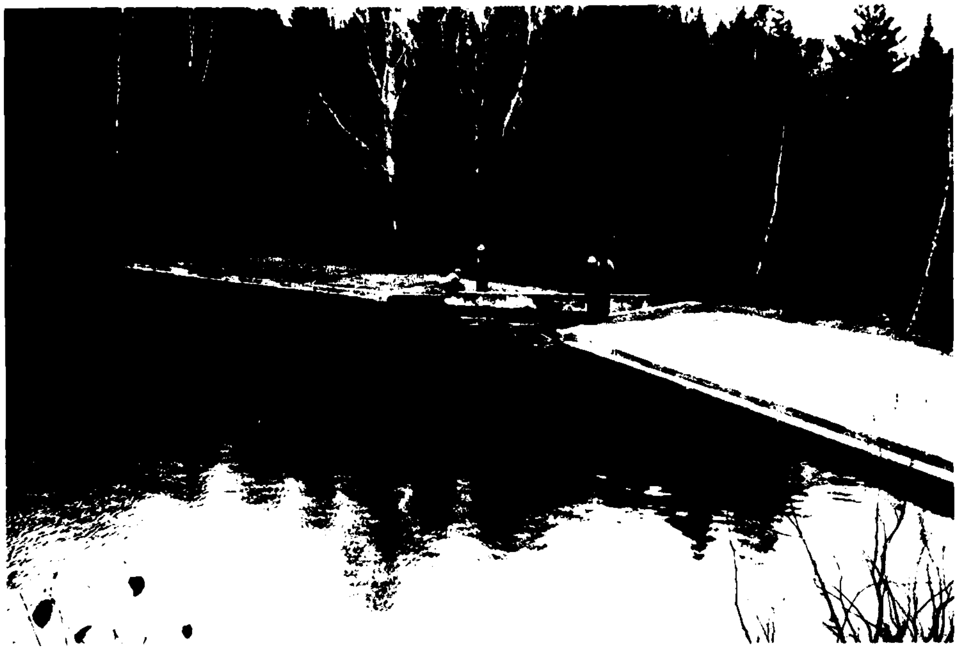
APPENDIX C

PHOTOGRAPHS

FOR LOCATION OF PHOTOS, SEE FIGURE B-1
LOCATED IN APPENDIX B

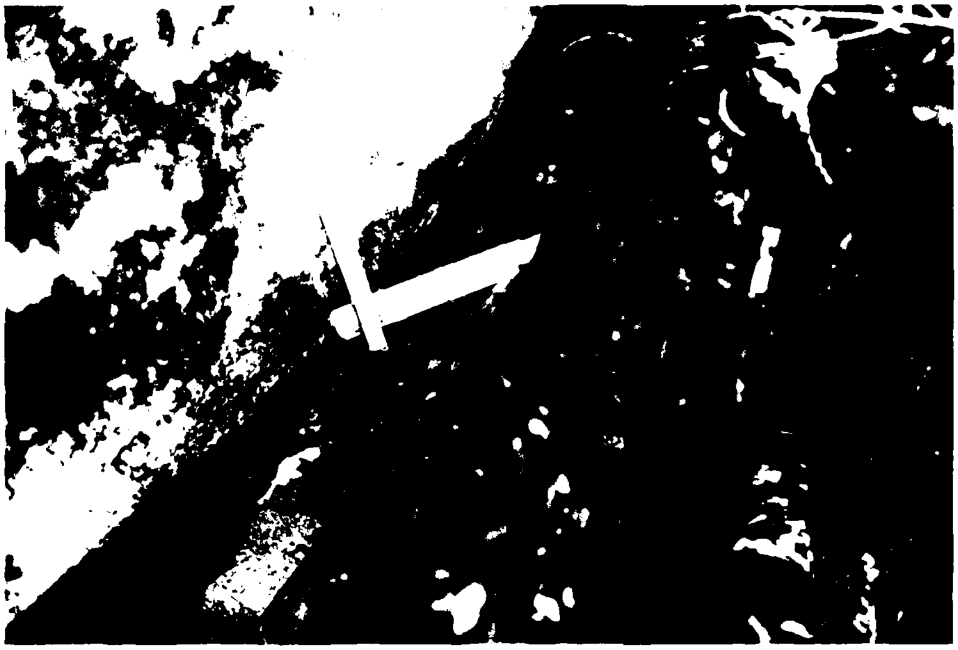
1. Downstream face of left side of dam

2. Upstream view of dam from left

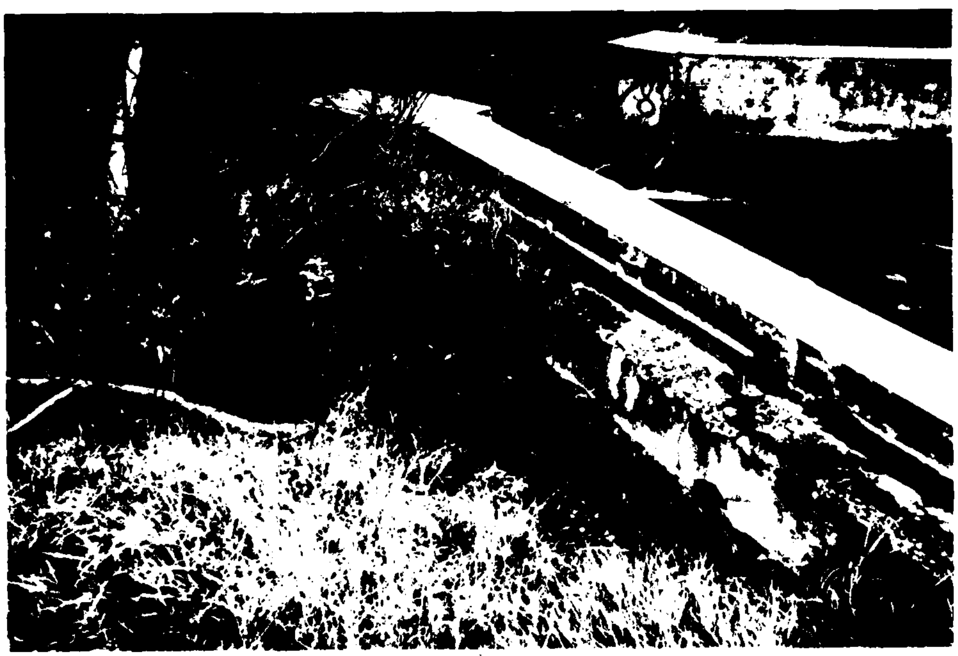


3. Upstream view of dam from right abutment

4. Close-up of upstream concrete wall.



5. Base of wall, left side of dam



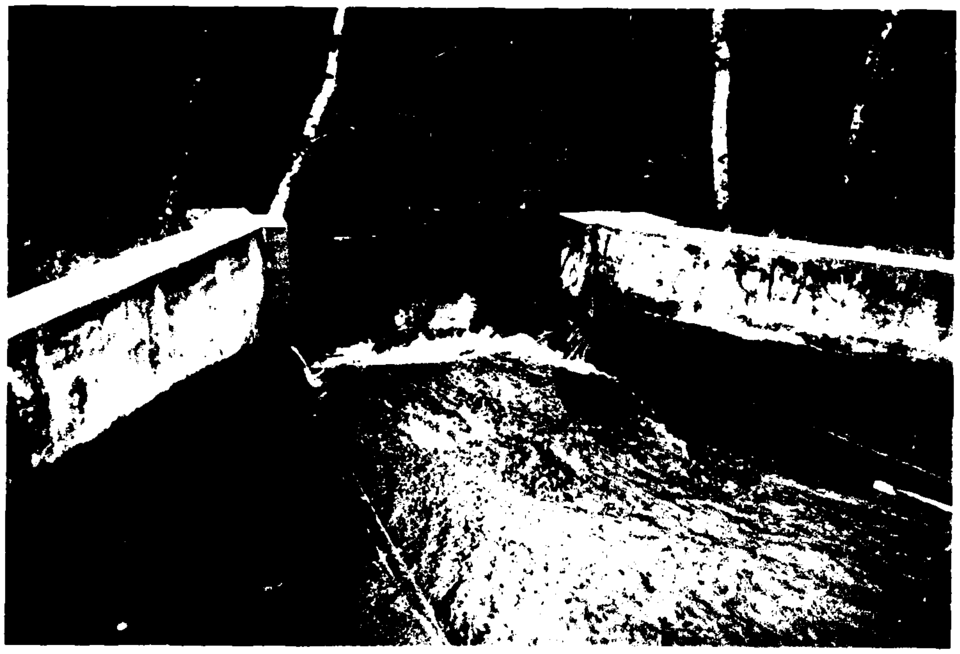
6. Cavity to the left of spillway

7. Wall to right of spillway

8. Wall to left of spillway

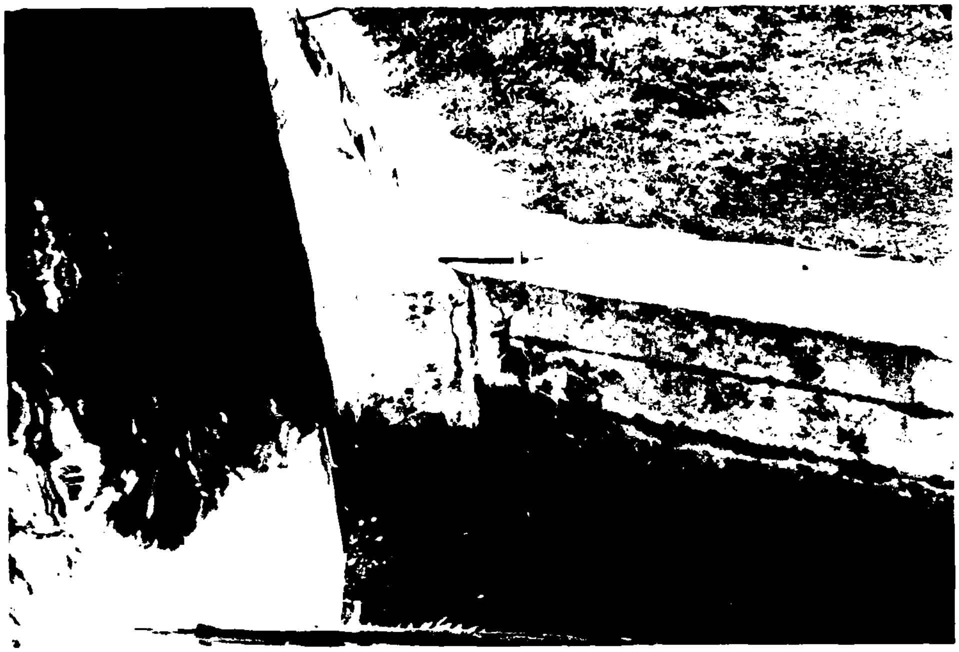
9. Left wall showing efflorescence

10. Right bank, downstream of dam



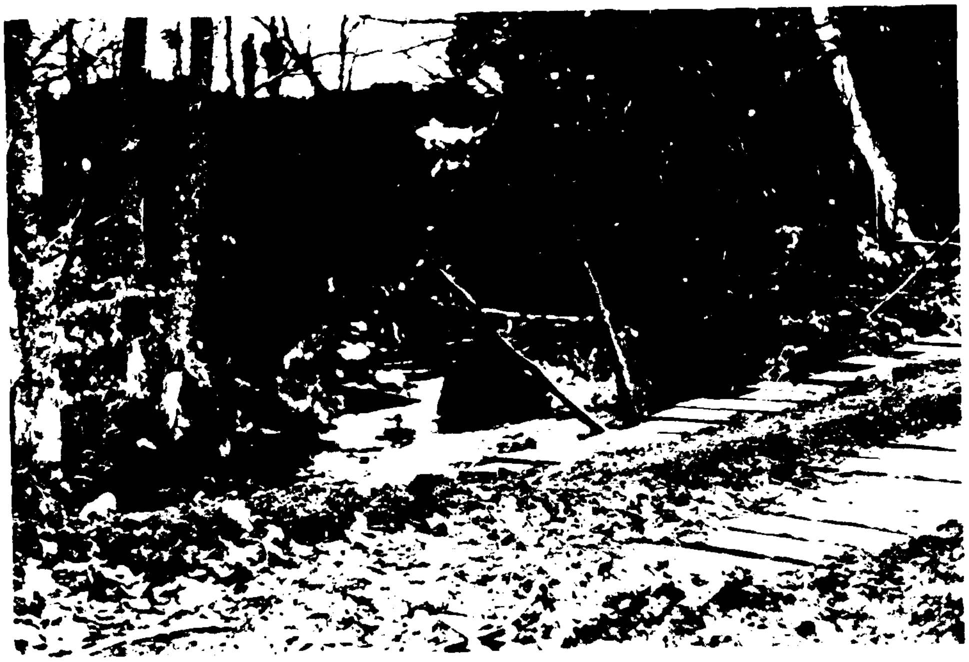
11. Spillway looking downstream

12. Spalled area of spillway



13. Condition of spillway walls

14. Downstream face of spillway



15. View of dam from downstream

16. Gate operating mechanism

APPENDIX D

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Surcharge height$_5$ = surcharge height$_4$ = 5.34 ≈ 5.3' (el 1...

Values will not change, no further iterations necessary

Since dam is overtopped, ½ PMF must be routed to determine spillway adequacy

Q_{P_1} = 4050 cfs surcharge height$_1$ = 4.6' (el 1212.6')

$STOR_1$ = 4120 - 3251 = 869 a-f

$$STOR_1 = \frac{869 \text{ a-f} \times 12''/\text{ft}}{3.44 \text{ mi}^2 \times 640 \text{ acres}/\text{mi}^2} = 4.7366''$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{9.5''}\right) = 4050\left(1 - \frac{4.7366}{9.5}\right) = 2031 \text{ cfs}$$

surcharge height$_2$ = 3.3' (1211.3')

$STOR_2$ = 3860 - 3251 = 609 a-f

$$STOR_2 = \frac{609 \times 12}{3.44 \times 640} = 3.3194''$$

$$STOR_{ave} = (3.3194 + 4.7366)/2 = 4.0280$$

$$Q_{P_3} = 4050\left(1 - \frac{4.0280}{9.5}\right) = 2333 \text{ cfs}$$

surcharge height$_3$ = 3.5' (el 1211.5')

$STOR_3$ = 3900 - 3251 = 649 a-f

$$STOR_3 = \frac{649 \times 12}{3.44 \times 640} = 3.5374''$$

$$STOR_{ave} = (3.5374 + 4.0280)/2 = 3.7827''$$

$$Q_{P_4} = 4050\left(1 - \frac{3.7827}{9.5}\right) = 2437 \text{ cfs}$$

surcharge height$_4$ = 3.65' (1211.65')

King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

No. 9110 Sheet 13 of 44
ect East Long Pond Dam Date 1/28/80
ject Hydraulics / Hydrology By RMC Ch'k. by

TEP 3 EFFECT OF SURCHARGE STORAGE ON PMF

Q_{P_1} = 8100 cfs Height of surcharge$_1$ = 6.4' (@ 1214.4) (see rating curve)

SURCHARGE VOLUME = TOTAL VOLUME − NORMAL POOL VOLUME (from elevation volume curve)

$STOR_1 = 4480 - 3251 = 1229$ a-f

$$STOR_1 = \frac{1229 \text{ a-f} \times 12 \text{ ''/ft}}{3.44 \text{ mi}^2 \times 640 \text{ acre/mi}^2} = 6.6988''$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{19''}\right) = 8100\left(1 - \frac{6.6988}{19}\right) = 5244 \text{ cfs}$$

SURCHARGE HEIGHT$_2$ = 5.18' (el 1213.18')

$STOR_2 = 4260 - 3251 = 1009$ a-f

$$STOR_2 = \frac{1009 \times 12}{3.44 \times 640} = 5.4996''$$

$STOR_{AVE} = (5.4996 + 6.6988)/2 = 6.0992''$

$$Q_{P_3} = 8100\left(1 - \frac{6.0992}{19}\right) = 5500 \text{ cfs}$$

SURCHARGE HEIGHT$_3$ = 5.3' (el 1213.3)

$STOR_3 = 4280 - 3251 = 1029$ a-f

$$STOR_3 = \frac{1029 \times 12}{3.44 \times 640} = 5.6086''$$

$STOR_{AVE} = (5.6086 + 6.0992)/2 = 5.8539''$

$$Q_{P_4} = 8100\left(1 - \frac{5.8539}{19}\right) = 5604 \text{ cfs}$$

SURCHARGE HEIGHT$_4$ = 5.33' (el 1213.33)

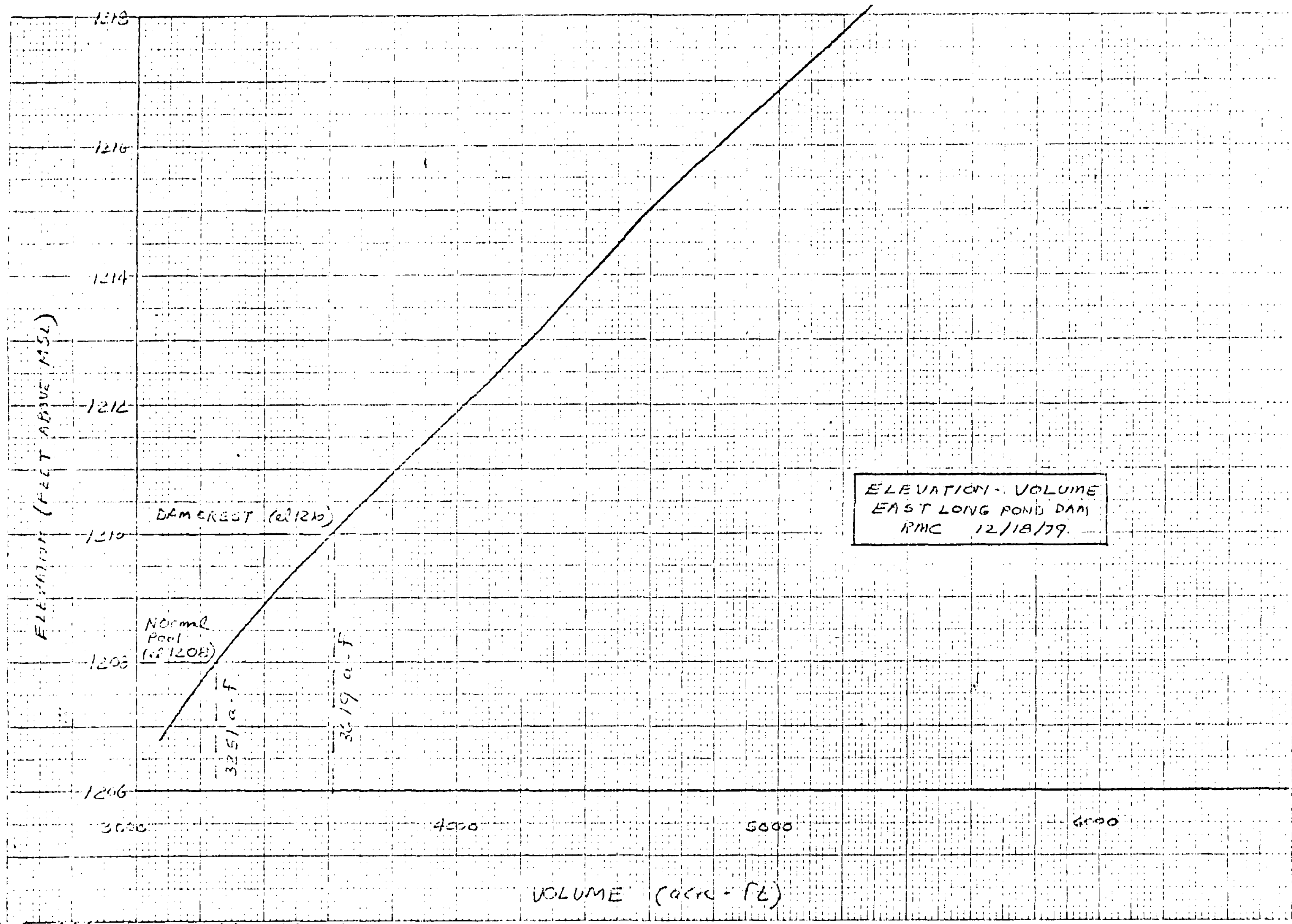
$STOR_4 = 4290 - 3251 = 1039$ a-f

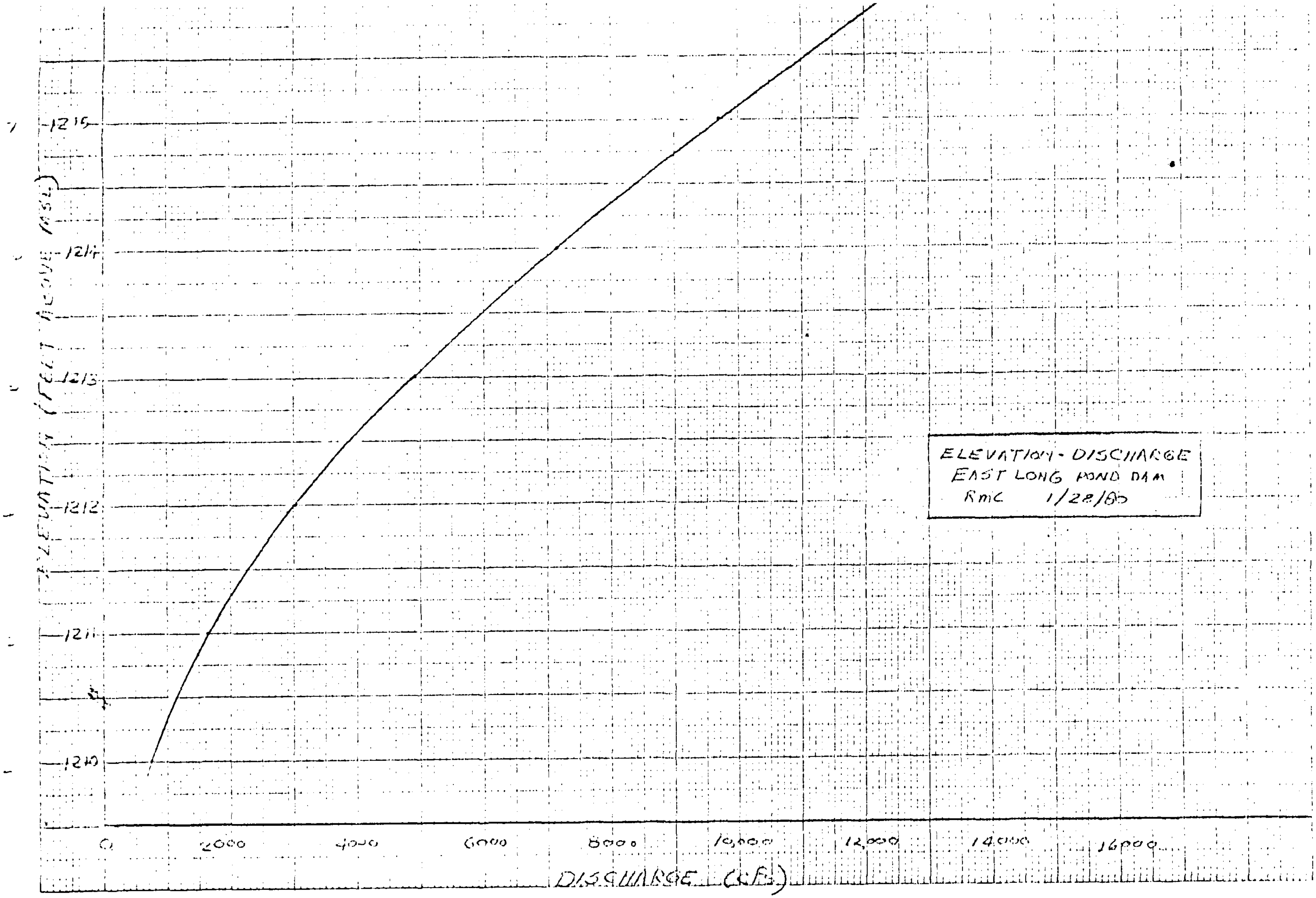
$$STOR_4 = \frac{1039 \times 12}{3.44 \times 640} = 5.6632 \text{ cfs}$$

$STOR_{AVE} = (5.6632 + 5.8539)/2 = 5.7586''$

$$Q_{P_5} = 8100\left(1 - \frac{5.7586}{19}\right) = 5645 \text{ cfs}$$

SURCHARGE HEIGHT$_5$ = 5.34' (el 1213.34).


ELEVATION - VOLUME
EAST LONG POND DAM
RMC 12/18/79
ELEVATION (FEET ABOVE MSL)
VOLUME (acre - ft)
1218
1216
1214
1212
1210
1208
1206
3000
4000
5000
6000
DAMCREST (el 1210)
Normal Pool (el 1208)
3251 a-f
3619 a-f


ELEVATION - DISCHARGE
EAST LONG POND DAM
RMC 1/28/80
ELEVATION (FEET ABOVE MSL)
1215
1214
1213
1212
1211
1210
DISCHARGE (CFS)
0
2000
4000
6000
8000
10,000
12,000
14,000
16000

s & King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

Job No. 79110 Sheet 10 of 44
Project East Long Pond Dam Date 1/28/80
Subject Hydraulics / Hydrology By RMC Ch'k. by

WATER ELEVATION	AUXILLARY SPILLWAY (12')		EMERGENCY SPILLWAY (80')		DAM CREST (el 1210.0)		DAM CREST (el 1211.3)		DAM CREST (el 1211.5)		TOTAL
	Head	Flow	Head	Flow	Head	Flow	Head	Flow	Head	Flow	FLOW
(ft)	(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(ft)	(cfs)	(ft)	cfs	(cfs)
1208	0	–	–	–	–	–	–	–	–	–	0
1209	0.2	3	1.0	248	0	–	0	–	0	–	251
1210	1.2	46	2.0	701	0	–	0	–	0	–	747
1211	2.2	114	3.0	1289	1.0	247	0	–	0	–	1650
1212	3.2	199	4.0	1984	2.0	699	0.7	122	0.5	18	3022
1213	4.2	300	5.0	2773	3.0	1283	1.7	461	1.5	96	4913
1214	5.2	413	6.0	3645	4.0	1976	2.7	923	2.5	206	7163
1215	6.2	537	7.0	4593	5.0	2762	3.7	1480	3.5	341	9713
1216	7.2	672	8.0	5612	6.0	3630	4.7	2119	4.5	496	12529

DAM CREST - ELEVATION 1211.5'

RIGHT EMBANKMENT

majority of 85 foot right embankment is a hill which will not be overtopped ($\approx$ 5' above left embankment). But small length of embankment before and after hill will conduct flow - Length $\approx$ 20' - Elevation 1211.5

$$Q = C L H^{3/2}$$

C = 2.6 (conservative)

$$Q = 2.6(20)(H^{3/2})$$

L = 20'

$$Q = 52 H^{3/2}$$

36" ϕ OUTLET PIPE - ASSUMED NON-EFFECTIVE IN FLOW COMPUTATIONS BECAUSE IT HAS A GATED OPENING. OPENING MECHANISM HAS BEEN REMOVED, AND IF REINSTALLED WOULD BE IN MIDDLE OF SPILLWAY, MAKING USE DURING FLOOD IMPROBABLE

EMERGENCY SPILLWAY - CREST ELEVATION 1208'

$Q_{ES} = C_w L H^{3/2}$

$L = 80'$

$C_w = 3.1$ (conservative value chosen due to field conditions)

$Q_{ES} = 3.1(80) H^{3/2}$

$Q_{ES} = 248 H^{3/2}$

DAM CREST - ELEVATION 1210'

Left Embankment near auxilliary spillway

$Q = C_w L H^{3/2}$

$L = 95'$

$Q = 2.6 (95) H^{3/2}$

$C_w = 2.6$ (conservative value chosen due to field conditions)

$Q = 247 H^{3/2}$

DAM CREST - ELEVATION 1211.3'

Left Embankment near left abutment

$Q = C_w L H^{3/2}$

$L = 80'$

$Q = 2.6(80) H^{3/2}$

$C_w = 2.6$ (conservative value chosen due to field conditions)

$Q = 208 H^{3/2}$

Job No. 7110 Sheet 7 of 44
Project EAST ... DAM Date 11/..../79
Subject HYDRAULICS / HYDROLOGY By ... Ch'k. by ...

STEP 1

CALCULATION OF SPILLWAY DESIGN FLOOD

CLASSIFICATION SIZE - INTERMEDIATE
HAZARD - HIGH

DAM SAFTEY GUIDELINES RECOMMEND

PMF

PMF FOUND ON PMF CURVE ENVELOPE

BASIN - MOUNTAINOUS

$PMF = 2350 \, cfs/mi^2$

$PMF = 2350 \frac{cfs}{mi^2} \times 3.44 \, mi^2 = 8084 \, cfs \approx 8100 \, cfs$

$PMF = 8100 \, cfs$

$\frac{1}{2} \, PMF = 4050 \, cfs$

OK

Should be deleted. Duplicates previous page

STEP 2 (cont.)

CALCULATION OF SURCHARGE BY FULL PMF

AUXILIARY SPILLWAY - CREST ELEVATION 1208.8'

$Q = C_w L H^{3/2}$

$L = 12$

$C_w = 2.9$ (conservative value chosen due to field - debris could obstruct weir)

$Q_{ms} = 2.9 \, (12) \, H^{3/2}$

$Q_{ms} = 34.8 \, H^{3/2}$

STEP 1 CLASSIFICATION OF SPILLWAY DESIGN FLOOD

CLASSIFICATION SIZE - INTERMEDIATE
HAZARD - HIGH

DAM SAFTEY GUIDELINES RECOMMEND

FULL PMF

PFM NOT FOUND ON PMF CURVE ENVELOPE, DUE TO DRAINAGE AREA BEING LESS THAN 2 mi^2. NEW ENGLAND DIVISION, CORPS OF ENGINEERS CONSULTED ON NOVEMBER 27, 1979. ENGINEER GARY JAMES RECOMMENDED USING SAME PMF/mi^2 AS EAST LONG POND DAM (1750' UPSTREAM) AND ADDING THE OUTPUT OF EAST LONG POND RESERVOIR TO GET THE INPUT PMF FOR NICHOLS POND RESERVOIR.

BASIN - MOUNTAINOUS

PMF FOR EAST LONG POND 2350 cfs/mi^2

DA FOR NICHOLS POND

$$PMF = 2350 \frac{cfs}{mi^2} \times 1.11 \, mi^2 = 2608.5 \text{ cfs}$$

OUTFLOW FROM EAST LONG POND (caused by PMF)

$$PMF = 2608.5 + 5645 \text{ cfs} = 8253.5 \approx 8300 \text{ cfs}$$

calculations shown on pages 7-14

PMF = 8300 cfs

OUTFLOW FROM East Long Pond (caused by ½ PMF)

$$\tfrac{1}{2} PMF = \frac{2608.5}{2} \text{ cfs} + 2455 \text{ cfs} = 3759.3 \text{ cfs} \approx 3800 \text{ cfs}$$

STEP 2 CALCULATION OF SURCHARGE BY PMF

DAM CREST ELEVATION 1130.5'

$$Q = C_w L H^{3/2}$$

$$Q = 200 (2.63) H^{3/2}$$

$$Q = 526 H^{3/2}$$

L = 200'
C_w = 2.63 from Kingard Brater Page 5-46, Table 5-3

BROAD CRESTED WEIR

NICHOLS POND DAM - Located in Woodbury, VT

CLASSIFICATION: SIZE - INTERMEDIATE (Based on storage)
HAZARD - HIGH (based upon location of downstream homes)

BASIC DATA:

DRAINAGE AREA: INDEPENDANT $1.11\ mi^2$
TOTAL $4.55\ mi^2$

RESERVOIR: NORMAL POOL ELEVATION 1128' (USGS)
STORAGE 2590.4 a-f

MAXIMUM POOL ELEVATION 1130.5'
STORAGE 2840.9 a-f

SURFACE AREA
161.9 acres (NORMAL POOL)
167 acres (MAXIMUM POOL)

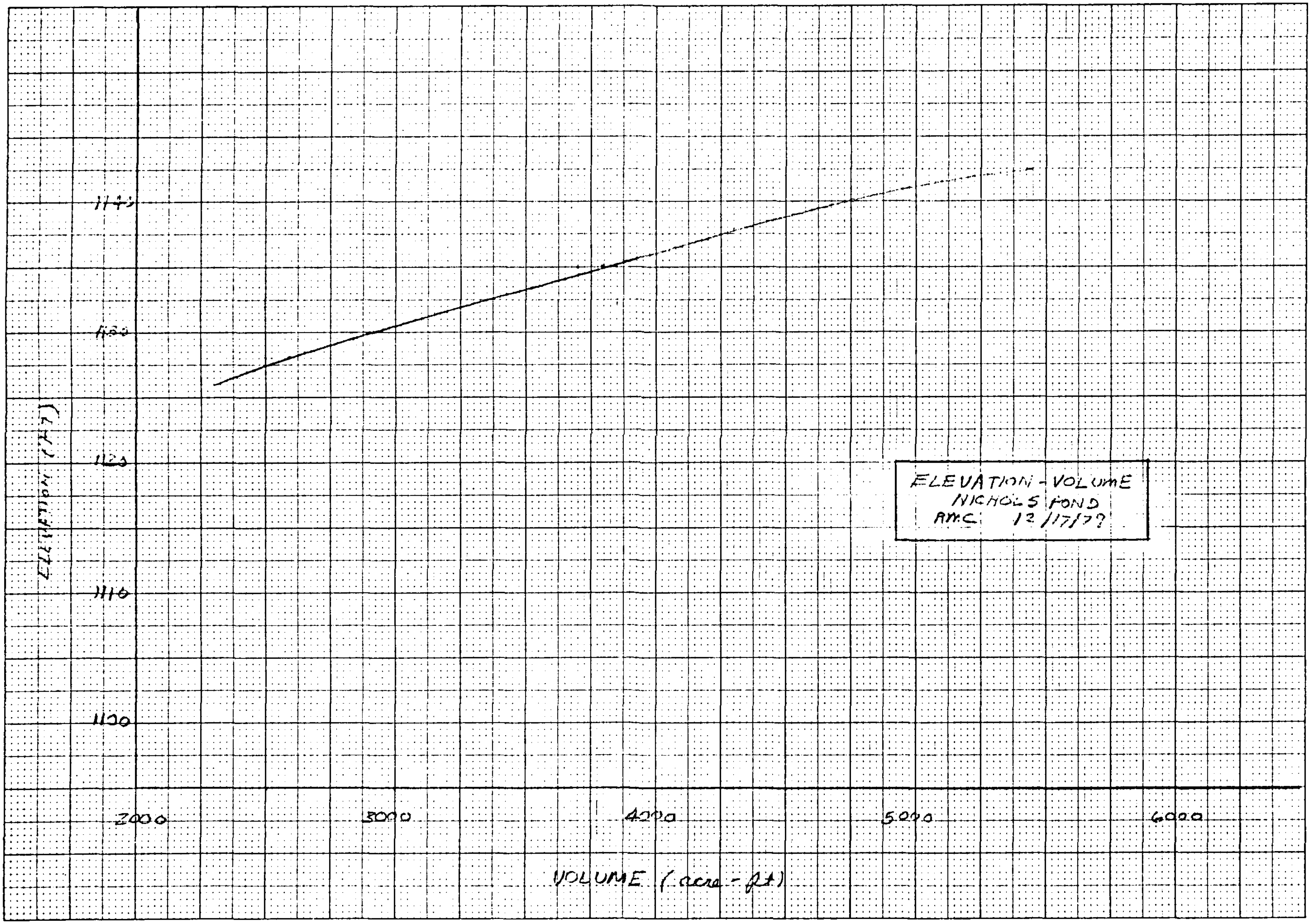
DAM: EARTH FILL WITH CONCRETE UPSTREAM WALL AND STONE MASONARY WALL DOWNSTREAM - BOTH WALLS VERTICAL

MAXIMUM HEIGHT - 18'
LENGTH - 200'

SPILLWAY: PRIMARY - TRIANGULAR SHAPED WEIR, TAPERS FROM 37' TO 7.5'

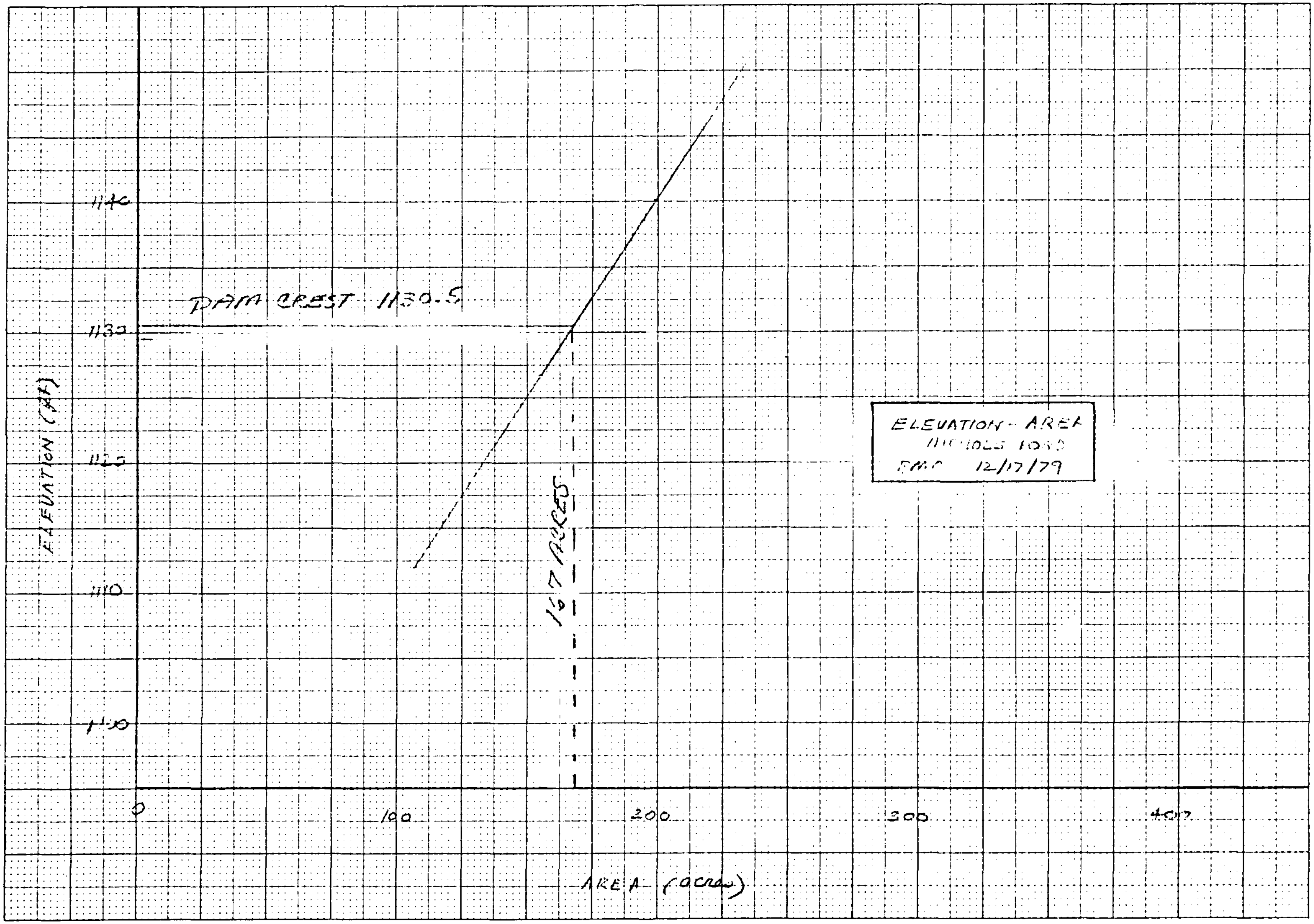
EMERGENCY - NONE

OUTLET: 5'X2' SLUICEWAY
INVERT 1117' ± AS PER STATE OF VERMONT SURVEY


1140
1130
1120
1110
1100
2000
3000
4000
5000
6000
VOLUME (acre-ft)
ELEVATION - VOLUME
NICHOLS POND
AMC 12/17/77

Job No. 91118 Sheet 3 of 44
Project Nichols Pond Dam Date 12/17/79
Subject Elevation - Volume Curve By RMC Ch'k. by

ELEVATION	Area (acres)	$\frac{A_1 + A_2}{2}$ (acres)	HEIGHT (ft)	INCREMENTAL VOLUME (a-F)	TOTAL VOLUME (a-F)
1128	161.9			–	2590.4
		164.45	1.5		
1129.5	167.0			246.7	2837.1
		168.0	0.5	84.0	2921.1
1130	169.0				
		175.75	5.0	878.8	3799.9
1135	182.5				
		190.75	5.0	953.8	4753.7
1140	199.0				


ELEVATION - AREA
12/17/79
DAM CREST 1130.5
167 ACRES
1140
1130
ELEVATION (ft)
0
100
200
300
400
AREA (acres)

Job No. 91118 Nichols Pond Sheet 1 of 44
Project DAM INSPECTION Date 11/20/7?
Subject RESERVOIR AREA By RAK Ch'k. by

NICHOLS POND DAM

NORMAL POOL SURFACE (ELEV. 1128') USGS

READING 1	READING 2	READING 3
0.27	0.52/2 = 0.26	0.78/3 = 0.26

AVERAGE = 0.78/3 = 0.26

AREA = 0.26 X 0.973 = 0.25 mi² X 640 = 161.9 acres

MAXIMUM POOL TO BE OBTAINED VIA GRAPH ON PAGE 2, UTILIZING POOL AREA AT NEXT CONTOUR LEVEL (1140')

READING 1	READING 2	READING 3
0.32	0.64/2 = 0.32	0.95/3 = 0.32

AVERAGE = 0.95/3 = 0.32

AREA = 0.973 X 0.32 = 0.31 mi² = 199 acres

NORMAL POOL STORAGE (1128') (vertical walls assumed)

HEIGHT TO SPILLWAY ≈ 16'

16' X 161.9 acres = 2590.4 acre-ft

SURCHARGE STORAGE (1129.5')

1.5' X 167 acres = 250.5 acre-ft

MAXIMUM POOL STORAGE

SUM OF SURCHARGE AND NORMAL STORAGE

2590.4 + 250.5 = 2840.9 acre-ft

$STOR_4 = 3930 - 3251 = 679$ a-f

$$STOR_4 = \frac{679 \times 12}{3.44 \times 640} = 3.7009''$$

$$STOR_{ave} = (3.7009 + 3.7827)/2 = 3.7418''$$

$$QP_5 = 4050\left(1 - \frac{3.7418}{9.5}\right) = 2455 \text{ cfs}$$

surcharge $height_6$ = 3.65' (el 1211.65)

surcharge $height_6$ = surcharge $height_5$ = 3.65' ≈ 3.7' (el 1211.7')
values will not change, no further iterations necessary

CONCLUSIONS

1) Reservoir storage will reduce the full PMF test inflow to an outflow of 5645 cfs (30% reduction). The ½ PMF test inflow will be reduced, due to reservoir storage, to 2455 cfs (39% reduction)

2) The spillways can only pass 747 cfs before the dam is overtopped (13% of test outflow of 5645 cfs; 30% of test outflow of 2455 cfs)

3) The PMF will cause a dam overtopping of 3.3' (el. 1213.3'). ½ PMF causes the dam to be overtopped by 1.7' (el 1211.7')

OUTLET ASSUMED NON EFFECTIVE IN FLOW COMPUTATIONS BECAUSE OUTLET IS GATED. GATE OPENING MECHANISM HAS BEEN REMOVED. ALSO, THE OPERATOR WOULD HAVE TO STAND IN THE MIDDLE OF THE SPILLWAY TO OPERATE THE GATES, MAKING ITS USE UNLIKELY DURING A FLOOD.

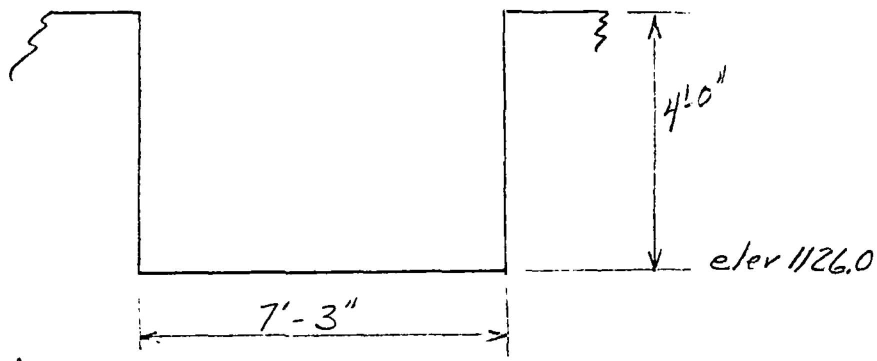
SPILLWAY

IRREGULAR SPILLWAY REQUIRES SPECIAL COMPUTATIONS TO DETERMINE IF INLET OR OUTLET CONTROLS FLOW. A RATING CURVE FOR THE SPILLWAY (shown on Page 6 of 16) INDICATES A CAPACITY OF 215cfs AT DAM CREST (ELEVATION 1130.5') CONSEQUENTLY WHEN THE ENTIRE DAM IS OVERTOPPED (ELEV. 1130.5'), THE SPILLWAY WILL BECOME INSIGNIFICANT IN FLOW CALCULATIONS; THE WEIR-LIKE FLOW OVER THE DAM CREST WILL DOMINATE.

Job No. 91118 Sheet 18 of 44
Project Nichols Pond Dam Date 11-28-79
Subject Spillway Rating Curve By JJ Ch'k. by

1. Rating curve for downstream end

a. Sketch:



b. find discharge for various depths at Critical Depth
Ref King & Brater p 8-8 (Formulae 8-29)

$$Q = \sqrt{g}\ b\ D_c^{3/2};\ (\sqrt{g} = 5.67;\ b = 7.25)$$

$$Q = 41.1\ D_c^{3/2}$$

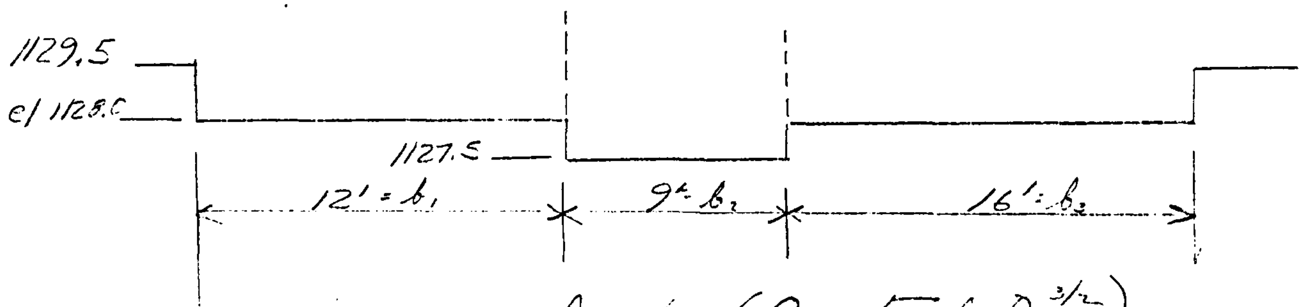
$EGL = Z_o + d_c + H_{vc}$, where $Z_o = 1126.0$; $H_v = \frac{D_c}{2}$

depth	$D_c^{3/2}$	Q	H_v	EGL
0.5	0.35	15	0.25	1126.8
1.0	1.0	41	0.5	1127.5
2.0	2.83	116	1.0	1129.0
3.0	5.2	214	1.5	1130.5
4.0	8.0	329	2.0	1132.0
6.0	14.7	603	3.0	1135.0
8.0	22.6	928	4.0	1138.0

Job No. 9116 Sheet 17 of 44
Project Nichols Pond Dam Date 11-28-79
Subject Spillway Rating Curves By [illegible] Ch'k. by

2. Rating curve for upstream end of spillway

a. sketch



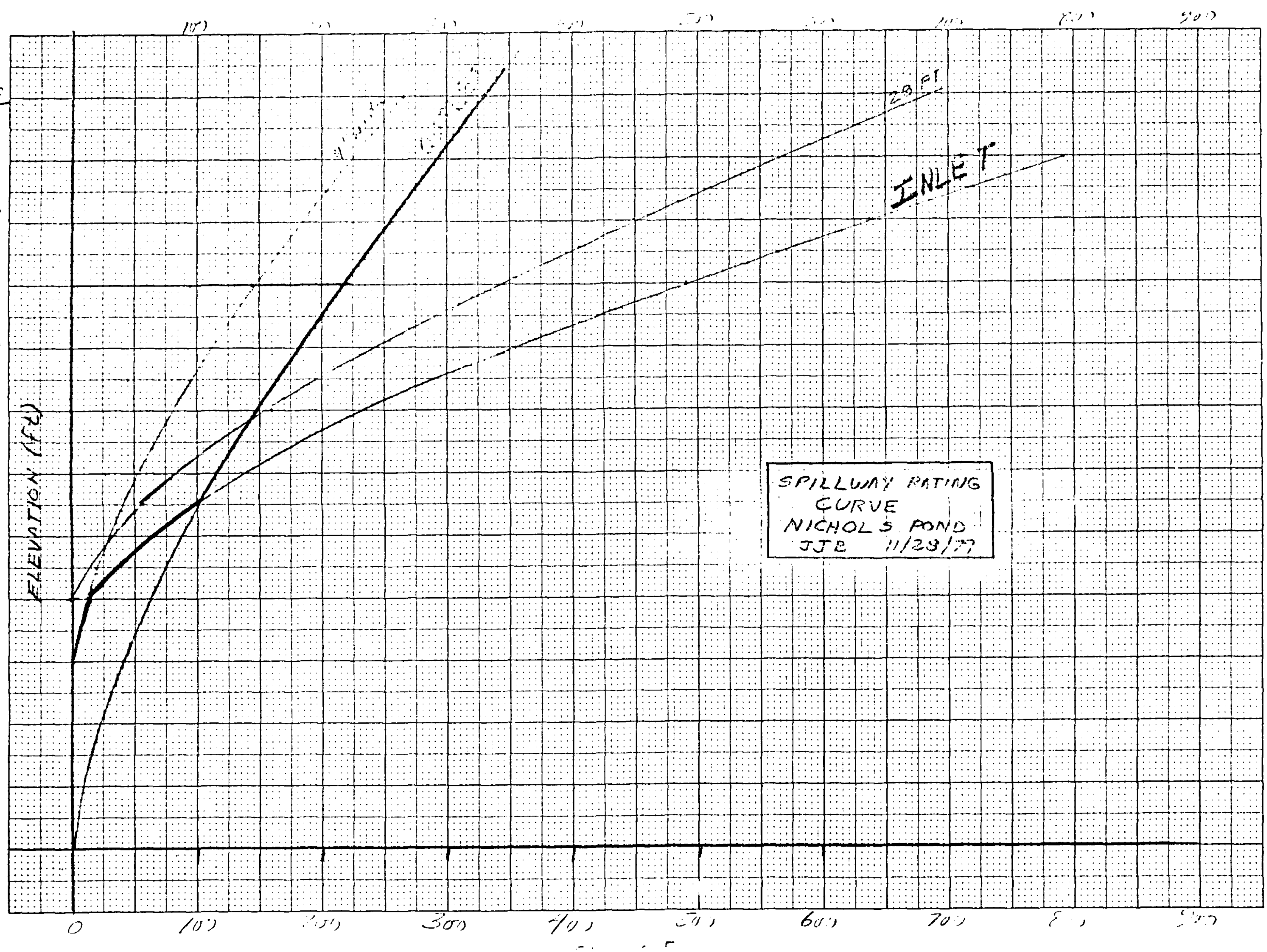
using same formula $(Q = \sqrt{g}\, b\, D_c^{3/2})$
we will combine b_1 and b_3 and investigate

$b_4 = b_1 + b_3 = 28'$

b. determine two rating curves and combine

$b_4 = 28$, $Q = 158.8\, D_c^{3/2}$

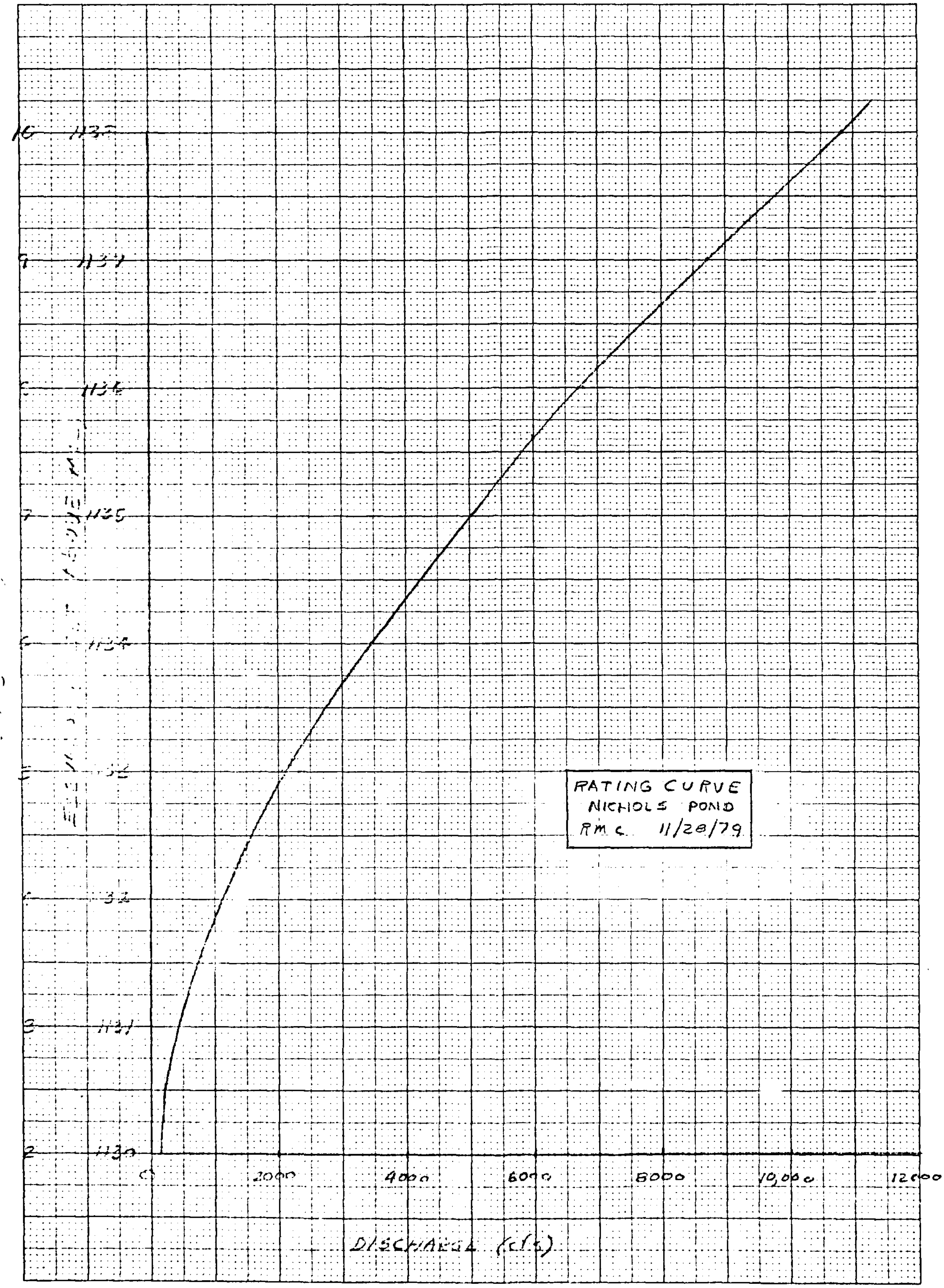
d Z_0 = 1128.0	$D_c^{3/2}$	Q	Hv	EGL
0.5	.35	56	0.25	1128.6
1.0	1.0	159	0.5	1129.5
1.5	1.84	292	0.75	1130.3
2.0	2.82	449	1.0	1131.0
2.5	3.95	628	1.25	1131.8
Z_0 = 1127.5		$b_2 = 9$, $Q = 51.0\, D_c^{3/2}$		
0.5	.35	18	0.25	1128.3
1.0	1.0	51	0.5	1129.0
1.5	1.84	94	0.75	1129.8
2.0	2.82	144	1.0	1130.5
2.5	3.95	202	1.25	1131.3
3.0	5.2	265	1.5	


SPILLWAY RATING
CURVE
NICHOLS POND
JJB 11/28/77
INLET
20 FT
ELEVATION (FT)
0
100
300
400
600
700

Job No. 91118 Sheet 19 of 44
Project NICHOLS POND DAM Date 11/28/79
Subject HYDRAULICS / HYDROLOGY By RMC Ch'k. by [illegible]

WATER SURFACE ELEVATION	PRIMARY SPILLWAY HEAD (ft)	PRIMARY SPILLWAY FLOW (cfs)	DAM CREST (el 1130.5) HEAD (ft)	DAM CREST (el 1130.5) FLOW (cfs)	TOTAL FLOW (cfs)
1127	0	–	0	–	0
1127.5	0	–	0	–	0
1128	0.5	13	0	0	13
1129	1.5	115	0	0	115
1130	2.5	183	0	0	183
1131	3.5	256	0.5	186	442
1132	4.5	330	1.5	966	1296
1133 *	–	–	2.5	2079	2079
1134 *	–	–	3.5	3444	3444
1130.5	3.0	218	0	0	218
1135 *	–	–	4.5	5021	5021
1136 *	–	–	5.5	6785	6785
1137 *	–	–	6.5	8717	8717
1138 *	–	–	7.5	10804	10804
1139 *	–	–	8.5	13035	13035

* Discharge over spillway not included above el. 1132 because configuration of dam is assumed to control


RATING CURVE
NICHOLS POND
RMC 11/28/79
DISCHARGE (cfs)
0
2000
4000
6000
8000
10,000
12000
1130
1131
1134
1135
1137
1138
10
9
7
6
3
2

STEP 3 EFFECT OF SURCHARGE STORAGE ON PMF

$Q_{P_1} = 8300$ cfs HEIGHT OF SURCHARGE$_1$ = 8.8' (el 1136.8')
(see Rating curve p. 20

$STOR_1$ = SURCHARGE VOLUME = TOTAL VOLUME − NORMAL POOL VOLUME (see elevation volume curve p. 4)

$STOR_1 = 4175 - 2590.4 = 1584.6$ a-f

$$STOR_1 = \frac{1584.6 \text{ a-f} \times 12 \text{ "/ft}}{4.55 \text{ mi}^2 \times 640 \text{ acre/mi}^2} = 6.5299 \text{"}$$

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{19"}\right) = 8300\left(1 - \frac{6.5299}{19}\right) = 5447 \text{ cfs}$$

SURCHARGE HEIGHT$_2$ = 7.3' (el 1135.3')

$STOR_2 = 3850 - 2590.4 = 1257.6$ a-f

$$STOR_2 = \frac{1259.6 \times 12}{4.55 \times 640} = 5.1707 \text{"}$$

$$STOR_{AVG} = (5.1907 + 6.5299)/2 = 5.8603 \text{"}$$

$$Q_{P_3} = 8300\left(1 - \frac{5.8603}{19}\right) = 5740 \text{ cfs}$$

SURCHARGE HEIGHT$_3$ = 7.45' (el. 1135.45')

$STOR_3 = 3900 - 2590.4 = 1309.6$ a-f

$$STOR_3 = \frac{1309.6 \times 12}{4.55 \times 640} = 5.3967 \text{"}$$

$$STOR_{AVG} = (5.3967 + 5.8603")/2 = 5.6285 \text{"}$$

$$Q_{P_4} = 8300\left(1 - \frac{5.6285}{19}\right) = 5841 \text{ cfs}$$

SURCHARGE HEIGHT$_4$ = 7.52' (el. 1135.52')

$STOR_4 = 3925 - 2590.4 = 1334.6$ a-f

$$STOR_4 = \frac{1334.6 \times 12}{4.55 \times 640} = 5.4997 \text{"}$$

Job No. 91118 Sheet 22 of 44
Project Nichols Pond Dam Date 4/10/80
Subject Hydraulics / Hydrology By RMC Ch'k. by

$STOR_{ave} = (5.4977 + 5.6285)/2 = 5.5641''$

$Q_{P_5} = 8300\left(1 - \frac{5.5641}{19}\right) = 5869$ cfs

surcharge $height_5 = 7.52$ (el. 1135.52)

Surcharge $height_5$ = surcharge $height_4$ = 7.52' ≈ 7.5'
[illegible] will not change, no further iterations necessary

Since the dam is overtopped, ½ PMF must be routed to determine spillway adequacy.

$Q_{P_1} = 3800$ cfs surcharge $height_1 = 6.4'$ (el. 1134.4')

$STOR_1$ = surcharge Volume = Total Volume - Normal pool volume

$STOR_1 = 3750 - 2590 = 1160$ a-f

$STOR = \frac{1160\ af \times 12''/ft}{4.55'' \times 640\ ft^2/acre} = 4.7802''$

Q_{P_1} $3800\left(1 - \frac{4.7802}{9.5}\right) = 1888$ cfs

surcharge $height_2 = 4.8'$ (el. 1132.8')

$STOR_2 = 3400 - 2590 = 810$ a-F

$STOR_2 = \frac{810 \times 12}{4.55 \times 640} = 3.3379''$

$Stor_{ave} = (3.3379 + 4.7802)/2 = 4.0591''$

$Q_{P_3} = 3800\left(1 - \frac{4.0591}{9.5}\right) = 2176$ cfs

surcharge $height_3 = 5.05'$ (el 1133.05'

$STOR_3 = 3425 - 2590 = 835$ a-f

$STOR_3 = \frac{835 \times 12}{4.55 \times 640} = 3.4407''$

$Stor_{ave} = (3.4407 + 4.0591)/2 = 3.7500''$

$Q_{P_4} = 3800\left(1 - \frac{3.7500}{9.5}\right) = 2300$ cfs

surcharge height$_4$ = 5.15' (el 1133.15')

$STOR_4$ = 3450 - 2590 = 860 a-f

$STOR_4 = \frac{860 \times 12}{4.55 \times 640} = 3.5440''$

Stor ave: $(3.5440 + 3.7500)/2 = 3.6470''$

$Q_{P5} = 3800 \left(1 - \frac{3.6470}{9.5}\right) = 2341$ cfs

surcharge height$_5$ = 5.18 ≈ 5.2' (el 1133.18') ≈ 1133.2'

surcharge height$_5$ = surcharge height$_4$ = 5.2' (el 1133.2')
no further iterations necessary

CONCLUSIONS

) Reservoir storage will reduce the full PMF test inflow to an outflow of 5869 cfs (29% reduction)
the ½ PMF test inflow will be reduced, due to reservoir storage, to 2341 cfs (38% reduction)

) The spillway can only pass 218 cfs before the dam is overtopped. (4% of test discharge of 5869 cfs; 9% of test discharge of 2341 cfs)

) The PMF will cause a dam overtopping of 5.0' (elev. 1135.5'). ½ PMF causes the dam to be overtopped by 2.7' (el. 1133.2')

DOWNSTREAM DAMAGE ESTIMATE

Corps of Engineers Recommends this procedure - Do breach
alysis w/ water at top of dam (full spillway capy
g used). Check to see if one or more homes will be
ected) IF so, use this case. IF not, try analysis w/water
top of spillway (neglible downstream flow). Using this
er of analysis, a case will be found which will
e damage or loss of life (the object of the analysis)

Case 1. Water at top of dam (el. 1130.5)

$Q_{P_1} = \frac{8}{27} W_b \sqrt{g}\; Y_0^{3/2} = \frac{8}{27}(0.40)(175)\sqrt{32}\; 20^{3/2} = 10{,}500$ cfs

= breach width

= height of water US of dam

initial downstream discharge = 218 cfs, stage = 1.8'

total flow after breach = 10,500 + 218 = 10718 cfs, stage = 13.9'

FLOOD WAVE = Δ stage = 13.9 - 1.8' = 12.1'

a 12.1' wave will cause damage d s of dam, hence
ase 1 will be used

STEP 1 Reservoir storage

@ el. 1130.5' = 2841 a-f

STEP 2 Peak Failure outflow

Q_{P_1} = (from above calculations) 10500 cfs

STEP 3 STAGE - DISCHARGE ROUTING CURVE

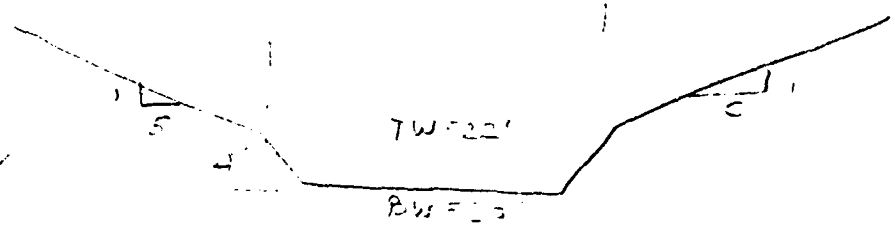
King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

No. 91118 — Sheet 24 of 44
Project: Nichols Pond Dam — Date 1/28/80
Subject: Hydraulics / Hydrology — By RMC Ch'k. by

$R = A/P$

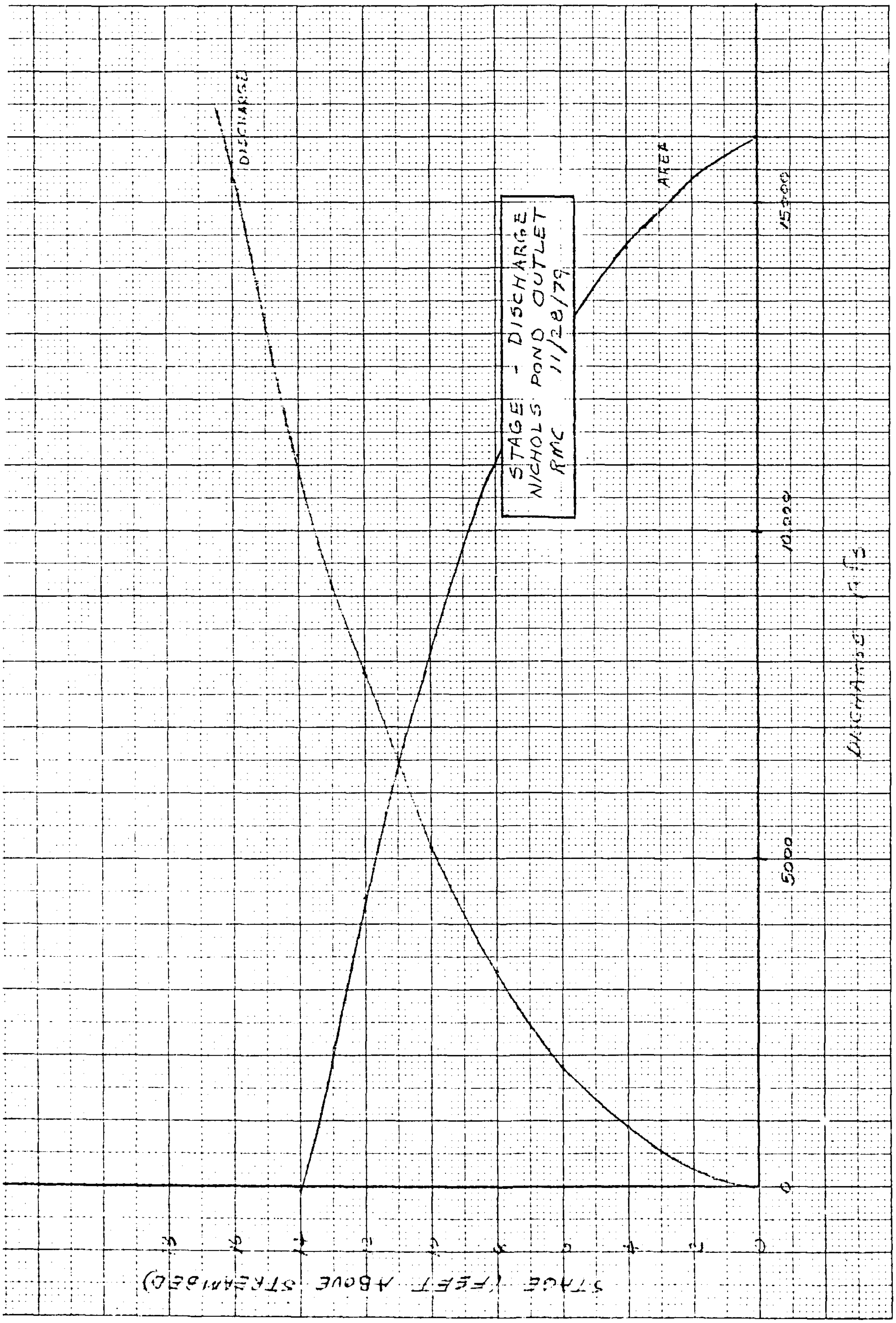
$L = 10,500'$

$S = \frac{1128 - 9??}{10,500} = 0.019\ \%$



n = 0.08 n = 0.0[illegible] n = 0.08

STAGE (ft)	CHANNEL AREA (ft²)	CHANNEL WETTED PERIMETER (ft)	CHANNEL FLOW (cfs)	RIGHT OVERBANK AREA (ft²)	RIGHT OVERBANK WETTED PERIMETER (ft)	RIGHT OVERBANK FLOW (cfs)	LEFT OVERBANK AREA (ft²)	LEFT OVERBANK WETTED PERIMETER (ft)	LEFT OVERBANK FLOW (cfs)	TOTAL AREA (ft²)	TOTAL FLOW (cfs)
4	84	28.25	[illegible]	–	–	–	–	–	–	84	895
6	128	28.25	[illegible]	10	10.2	25	10	10.2	25	148	1824
8	172	28.25	2709	40	20.4	160	40	20.4	160	252	3229
10	216	28.25	4246	90	30.6	471	90	30.6	471	396	5188
12	[illegible]	28.25	5777	160	40.8	1012	160	40.8	1012	580	7801
14	304	28.25	7489	250	51	1833	250	51	1833	804	11155
16	348	28.25	9372	360	61	2983	360	61	2983	1068	15339


STAGE - DISCHARGE
NICHOLS POND OUTLET
RMC 11/28/79
DISCHARGE
AREA
15000
10000
5000
0
DISCHARGE (CFS)
STAGE (FEET ABOVE STREAMBED)

CALCULATION OF SURCHARGE BY PMF

SPILLWAY ELEVATION 925.0'

$Q = C_w L H^{3/2}$

$Q = 3.1 (39) H^{3/2}$

$Q = 120.9 H^{3/2}$

$L = 23 + 16 = 39'$

$C_w = 3.1$ (based upon field conditions)

DAM CREST ELEVATION 927.0'

$Q = C_w L H^{3/2}$

$Q = 3.0 (41.5) H^{3/2}$

$Q = 124.5 H^{3/2}$

$L = 80.5 - 39 = 41.5'$

$C_w = 3.0$ (based upon field conditions)

DIKE ELEVATION 929.3'

THE ROADWAY TO THE LEFT OF THE DAM HAS HAD FLOOD WATERS USE IT AS AN EMERGENCY SPILLWAY. IT ILL BE CONCIDERED AS A WEIR WITH A LENGTH OF 5', VERTICAL WALLS ARE ASSUMED TO STAY CONSERVATIVE.

$Q = C_w L H^{3/2}$

$Q = 2.6 (75) (H^{3/2})$

$Q = 195 H^{3/2}$

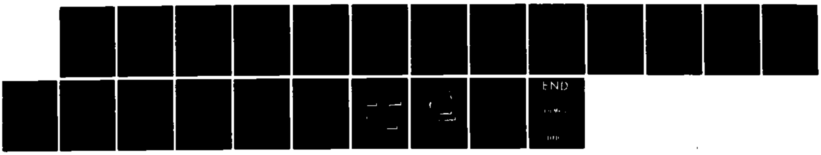
$L = 75'$

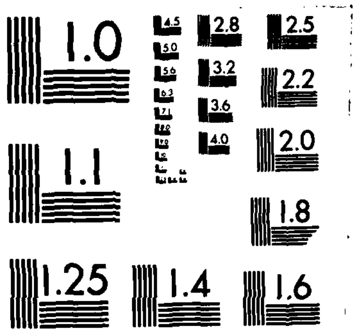
$C_w = 2.6$ (based upon field conditions)

OUTLET ASSUMED NON EFFECTIVE IN FLOW COMPUTATIONS. E WASTE GATE IS INOPERABLE AND THE PENSTOCK GATE OPENING CHANISM IS LOCATED IN THE MIDDLE OF THE SPILLWAY, RING ITS USE UNLIKELY DURING A FLOOD.

AD-A156 255 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
NICHOLS POND DAM (VT.. (U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV APR 80

UNCLASSIFIED F/G 13/13 NL

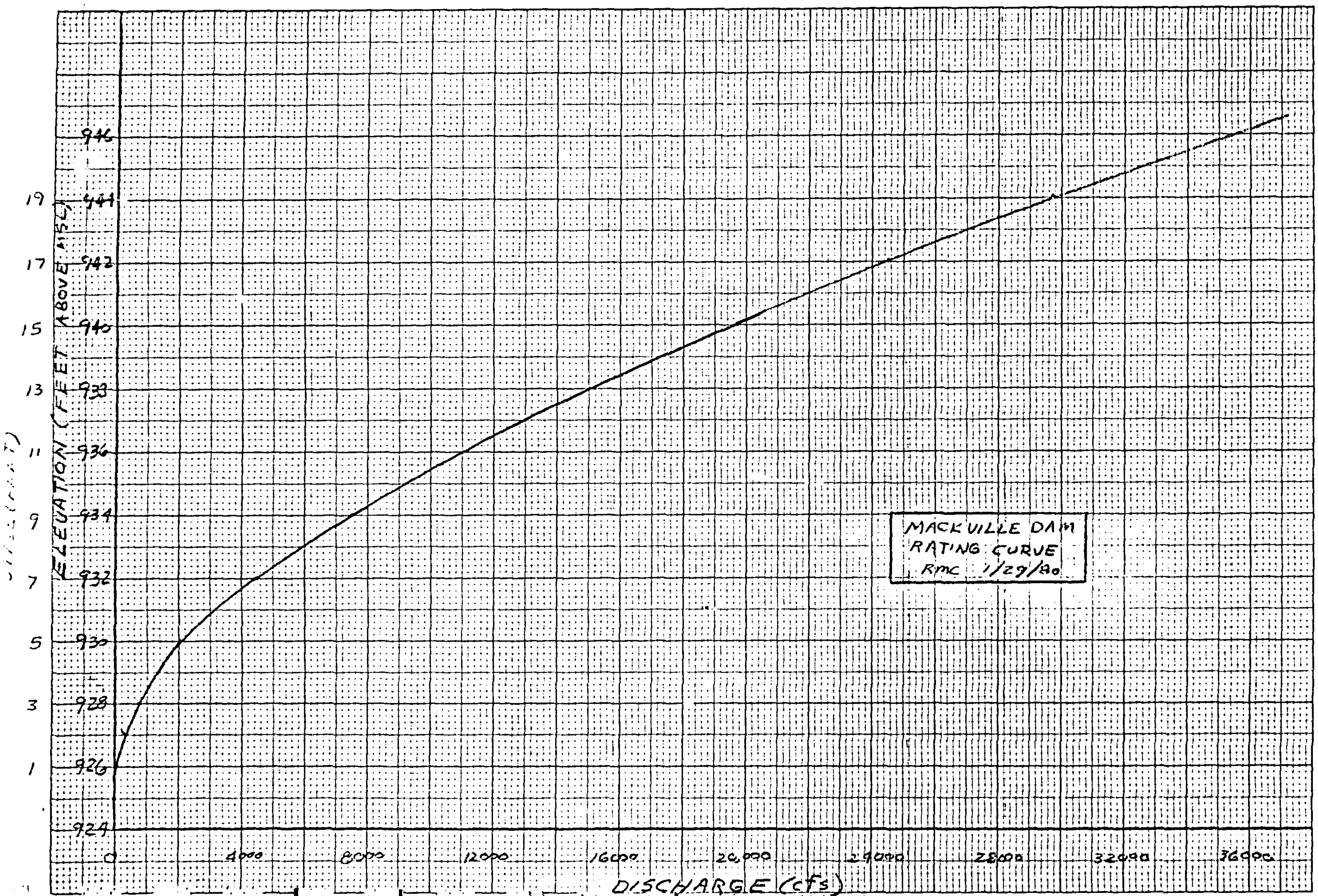




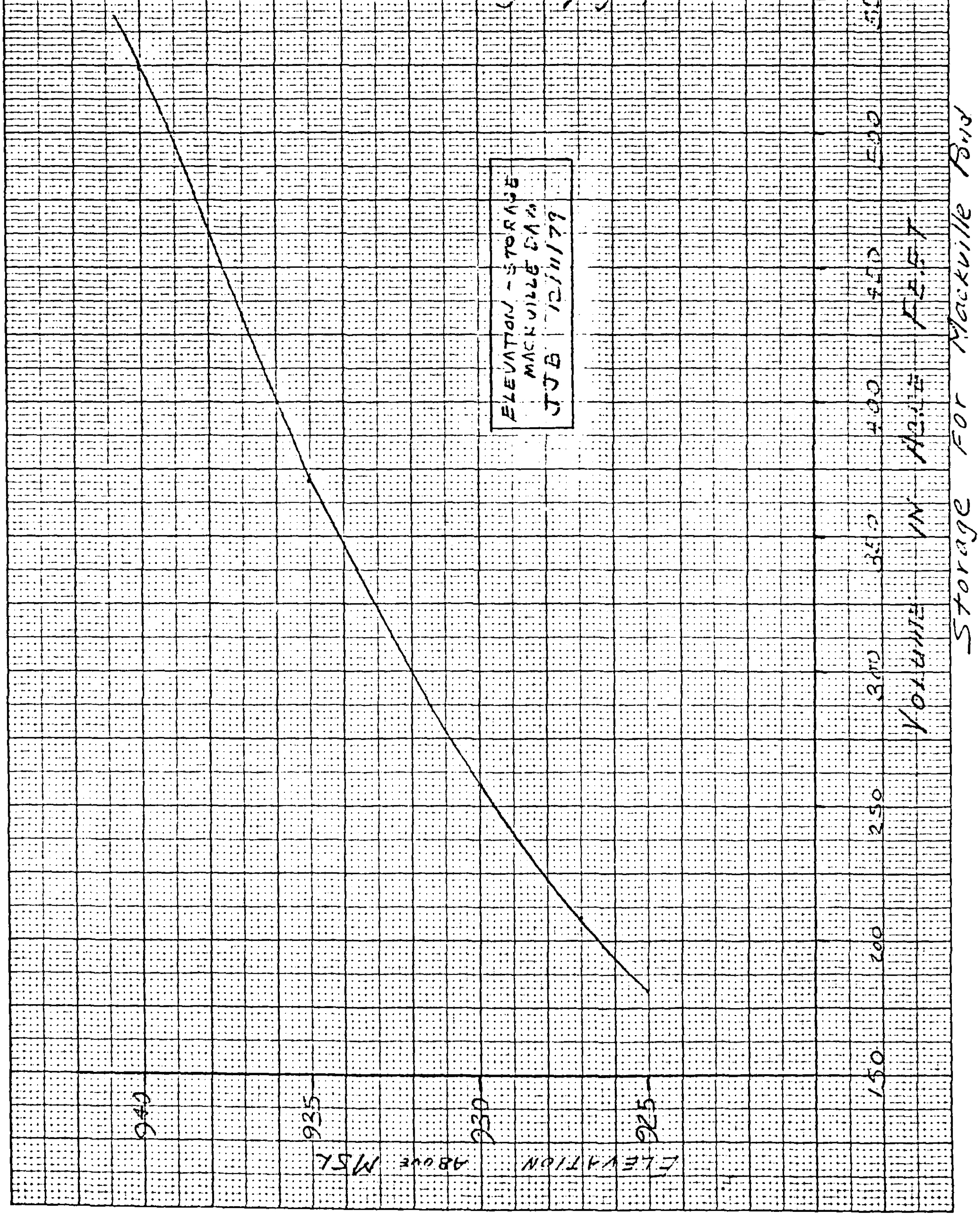
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Job No. 91116 | Sheet 27 of 44
Project Mackville Pond Dam | Date 1/29/80
Subject Hydraulics / Hydrology | By RMC Ch'k. by

ELEVATION (ft)	SPILLWAY ELEVATION (925) H (ft)	SPILLWAY Q (cfs)	Dam Crest (927) H (ft)	Dam Crest Q (cfs)	Roadway dike (929.3) H (ft)	Roadway dike Q (cfs)	TOTAL FLOW (cfs)
926	1	121	-	-	-	-	121
927	2	342	0	-	-	-	342
928	3	628	1	125	-	-	753
929.3	4.3	1078	2.3	434	0	-	1512
930	5	1352	3	647	0.7	114	2113
932	7	2239	5	1392	2.7	865	4496
934	9	3264	7	2306	4.7	1987	7557
936	11	4411	9	3362	6.7	3382	11,155
938	13	5667	11	4542	8.7	5004	15,213
940	15	7024	13	5836	10.7	6825	19685
942	17	8474	15	7233	12.7	8826	24,533
944	19	10,013	17	8727	14.7	10,990	29,730


MACKVILLE DAM
RATING CURVE
RMC 1/29/80
ELEVATION (FEET ABOVE MSL)
946
944
942
940
938
936
934
932
930
928
926
924
19
17
15
13
11
9
7
5
3
1
0
4000
8000
12000
16000
20,000
24000
28000
32000
36000
DISCHARGE (cfs)

Based on Available information:
USGS 15' Quadrangle, Plainfield, Vt
and DuBois and King Topographic Data

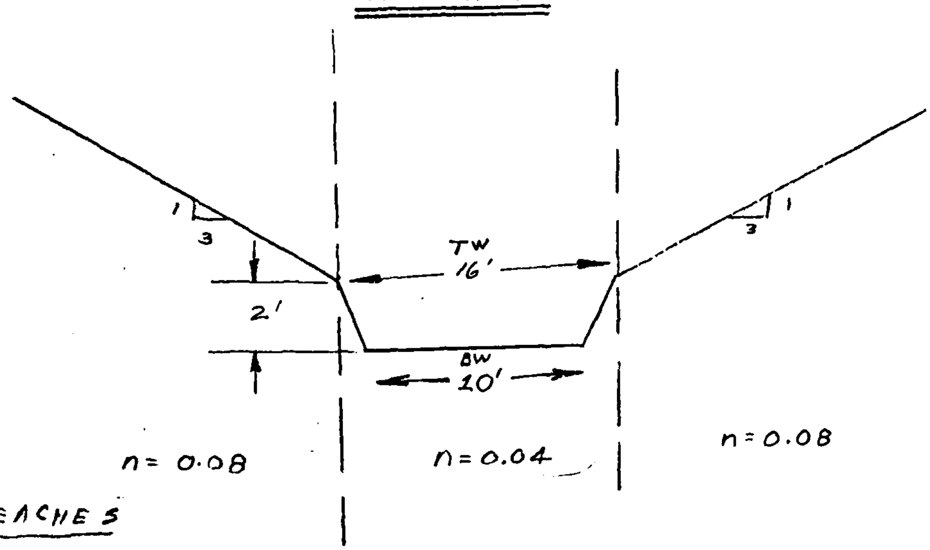


STEP 3

STAGE - DISCHARGE ROUTING CURVE

DOWNSTREAM XS APPROXIMATED FROM X SECTIONAL DATA SURVEYED BY DUBOIS AND KING PERSONNEL RELATING TO FLOOD INSURANCE STUDY FOR TOWN OF HARDWICK, VT

REACH 1



2 REACHES

Reach$_1$ $L = 1500'$
$\Delta elev = 23'$
$S = \frac{23}{1500} = 0.0153$

Reach$_2$ $L = 500$
$\Delta elev = 67'$
$S = \frac{67}{500} = 0.1340$

DuBois & King, Inc. ENGINEERING AND ENVIRONMENTAL SERVICES RANDOLPH VERMONT 05060

Job No. 91116 Sheet 31 of 44

Project Mackville Pond Dam Date 1/29/80

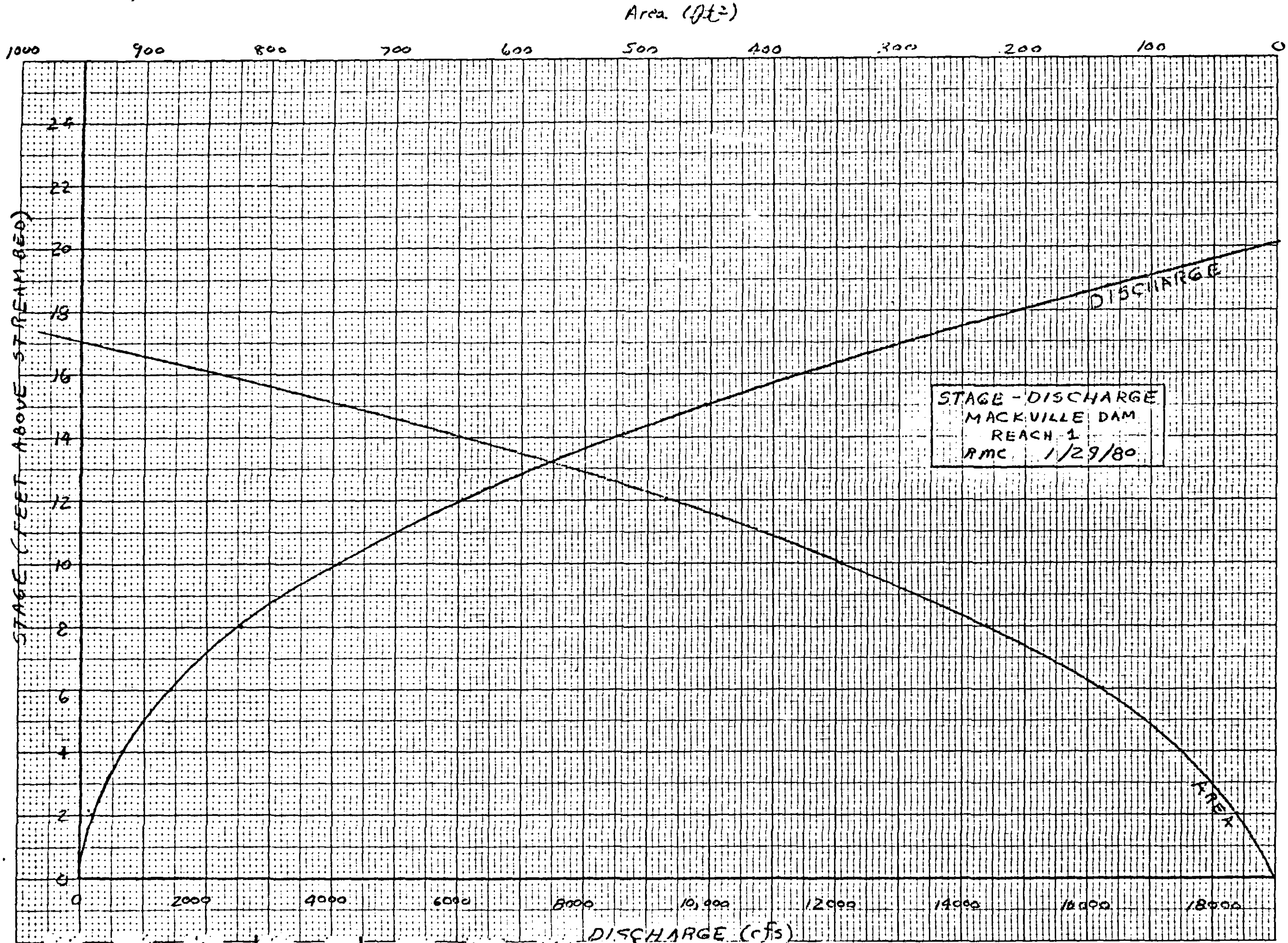
Subject Hydraulics By RMC Ch'k. by

MANNINGS EQUATION USED

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$R = A/P$

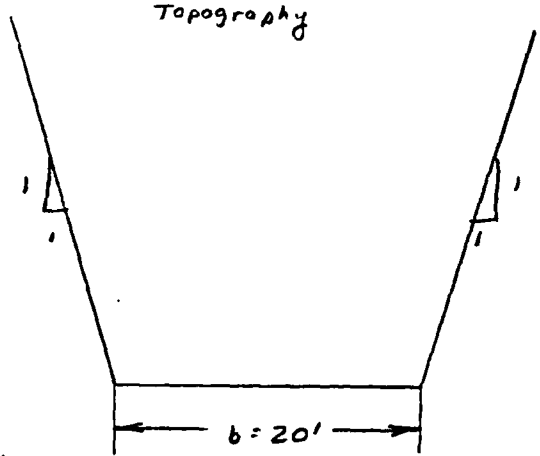
STAGE (ft)	CHANNEL AREA (ft^2)	CHANNEL WETTED PERIMETER (ft)	CHANNEL FLOW (cfs)	RIGHT OVERBANK AREA (ft^2)	RIGHT OVERBANK WETTED PERIMETER (ft)	RIGHT OVERBANK FLOW (cfs)	LEFT OVERBANK AREA (ft^2)	LEFT OVERBANK WETTED PERIMETER (ft)	LEFT OVERBANK FLOW (cfs)	TOTAL AREA (ft^2)	TOTAL FLOW (cfs)
2	26	17.2	158	-	-	-	-	-	-	26	158
4	58	17.2	600	6	6.3	13	6	6.3	13	84	626
6	90	17.2	1248	24	12.6	85	24	12.6	85	138	1418
8	122	17.2	2072	54	19	249	54	19	249	230	2570
10	154	17.2	3054	96	25.3	537	96	25.3	537	346	4128
12	186	17.2	4125	150	31.6	966	150	31.6	966	486	6057
15	234	17.2	6038	253.5	41.1	1940	253.5	41.1	1940	741	9919
18	282	17.2	8231	384	50.6	3370	384	50.6	3370	1050	14,972
21	330	17.2	10685	541.5	60.1	5323	541.5	60.1	5323	1413	21,331


Area (ft²)
1000
900
800
700
600
500
400
300
200
100
0
STAGE (FEET ABOVE STREAM BED)
24
22
20
18
16
14
12
10
8
6
4
2
0
DISCHARGE
AREA
STAGE - DISCHARGE
MACKVILLE DAM
REACH 1
RMC 1/29/80
0
2000
4000
6000
8000
10,000
12000
14000
16000
18000
DISCHARGE (cfs)

Job No. 91116 — Sheet 33 of 44
Project Mackville Dam — Date 1/29/80
Subject Hydraulics — By RMC Ch'k. by

REACH 2

XS Approximated from Topography



Reach Length = 500'

$\Delta elev = 887 - 820 = 67'$

$S = \Delta elev / L = 67/500 = 0.1340$

n = 0.08 rock channel, hvy. wood or

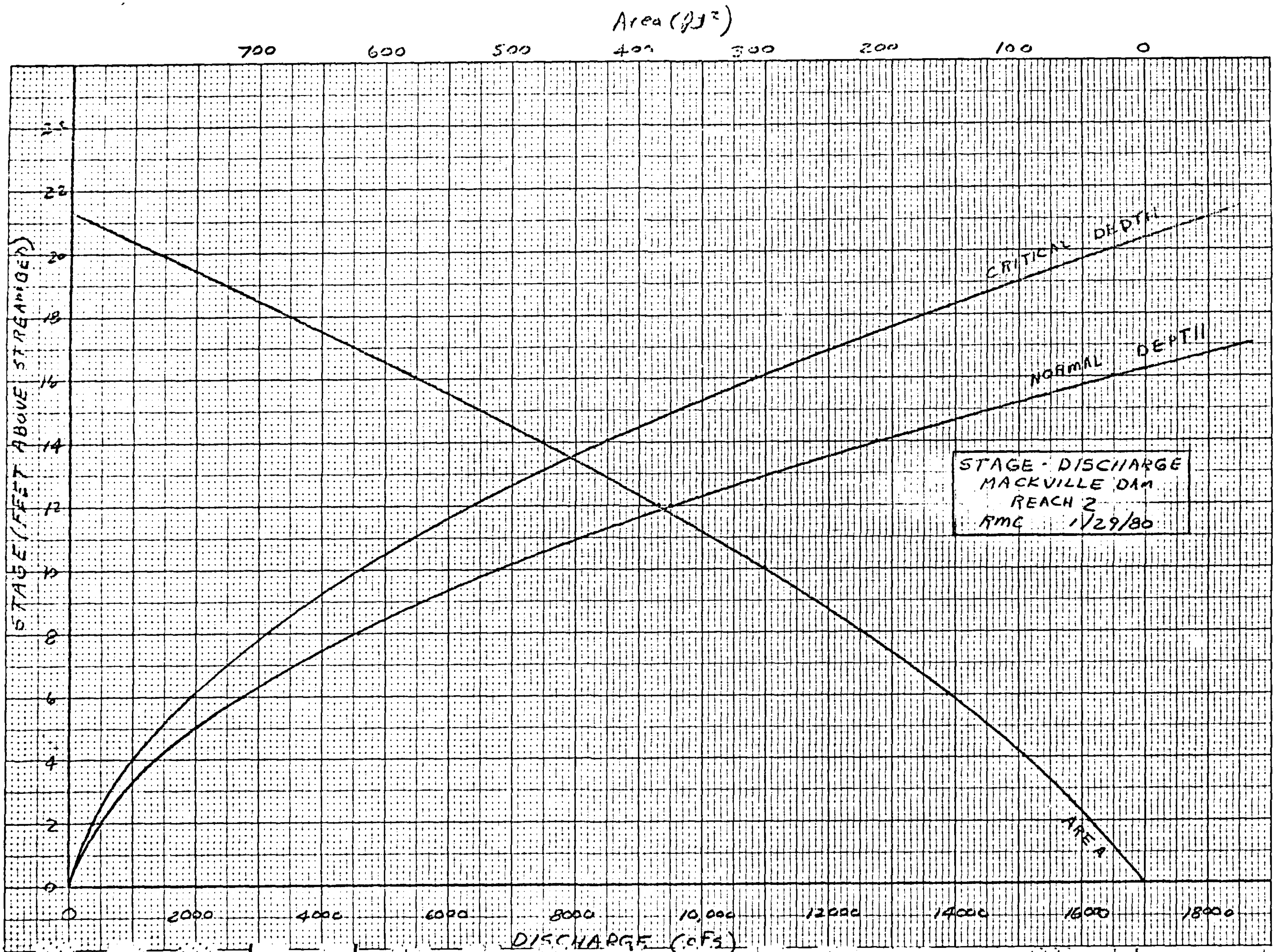
b) Normal depth found via Manning's equation $Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

c) Critical depth from table 8-4 King and Brater p. 8-53

* Refer to Hydraulic and Excavation tables USBR

d STAGE (ft)	A * AREA (ft^2)	R * HYDRAULIC RADIUS	$R^{2/3}$	B Q_n NORMAL FLOW (cfs)	C Q_c CRITICAL FLOW (cfs)
2	44	1.71	1.43	429	338
4	96	3.07	2.11	1377	1008
6	156	4.22	2.61	2770	1953
8	224	5.25	3.02	4603	3168
10	300	6.21	3.34	6809	4658
12	384	7.12	3.65	9538	6435
14	476	7.99	3.94	12,758	8500
16	576	8.83	4.21	16,492	10875

Assume critical depth at throat


Area (ft²)
700
600
500
400
300
200
100
0
STAGE (FEET ABOVE STREAMBED)
22
20
18
16
14
12
10
8
6
4
2
0
0
2000
4000
6000
8000
10,000
12000
14000
16000
18000
DISCHARGE (cfs)
CRITICAL DEPTH
NORMAL DEPTH
AREA
STAGE - DISCHARGE
MACKVILLE DAM
REACH 2
RMC 1/29/80

Job No. 9/116 Sheet 35 of 44
Project Mackville Pond Dam Date 1/29/80
Subject Hydraulics By RMC Ch'k. by

AT CONFLUENCE w/COOPER BROOK, FLOOD WAVE WILL MEET A LARGE OPEN AREA, which acts as a reservoir. ELEVATION-STORAGE CURVE WILL BE DERIVED, EFFECTS ON FLOOD WAVE WILL BE DETERMINED USING OUTLET CHANNEL AS A CONTROL.

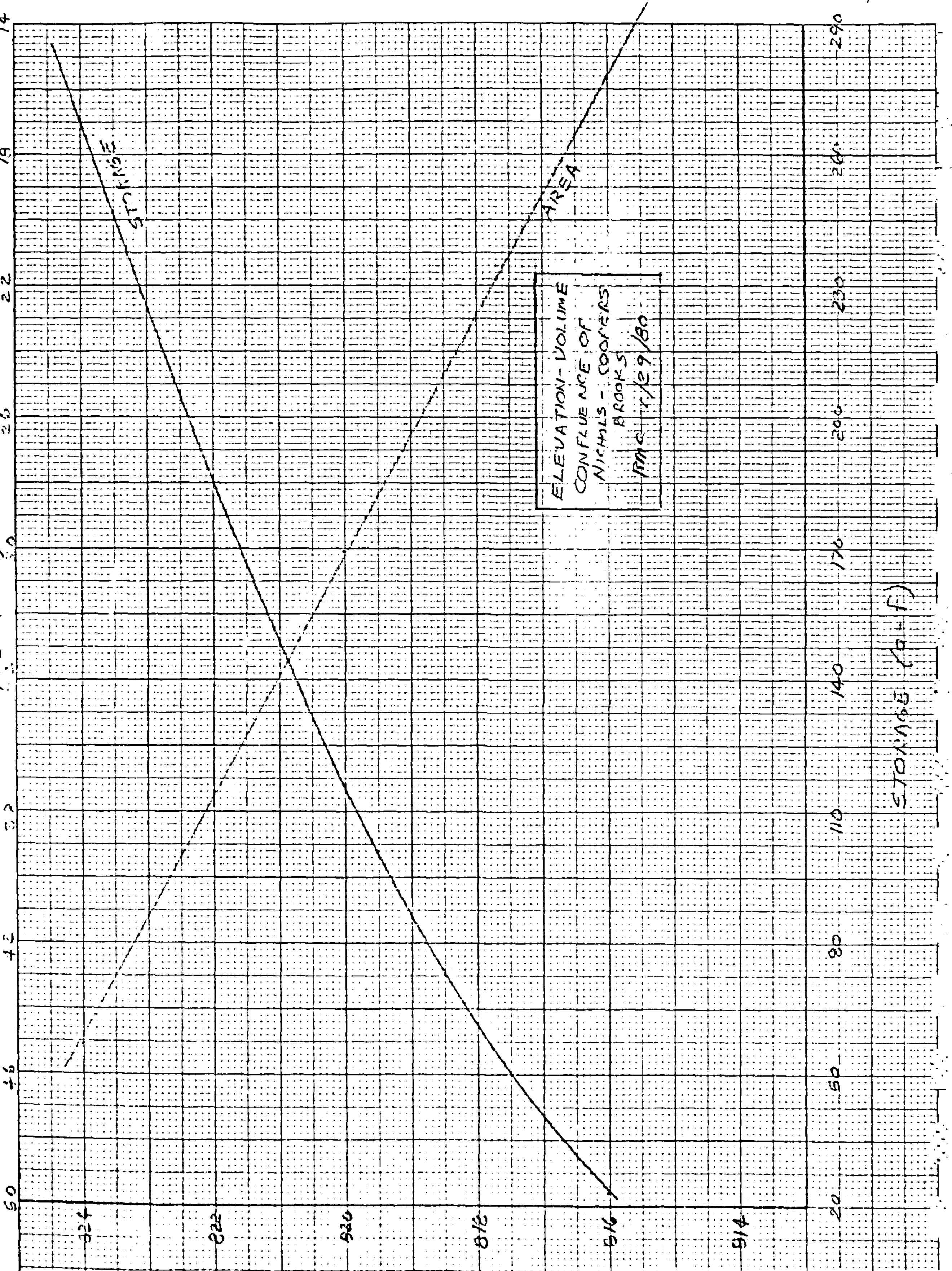
MAP SCALE 1" = 400'

CONVERSION FACTOR FOR PLANIMETER

$$1 \square'' = (400)^2 ft^2 \times \frac{1 \text{ acre}}{43560 ft^2} = 3.673 \text{ acre}$$

$$1 \square'' = 3.673 \text{ acre}$$

ELEVATION	PLANIMETER READINGS #1	#2	#3	AVERAGE	AREA	AVERAGE AREA	SLICE HEIGHT	INCREMENTAL VOLUME	TOTAL VOLUME
(ft)	(in²)	(in²)	(in²)	(in²)	(acre)	(acre)	(ft)	(a-f)	a-f
									0
313	—	—	—	—	0				
						7.88	3	23.64	23.64
316	4.27	4.29	4.31	4.29	15.76				
						23.14	4	92.56	116.20
320	8.32	8.30	8.30	8.31	30.51				
						38.09	4	152.36	268.5[illegible]
324	12.50	12.40	12.40	12.43	45.67				


ELEVATION-VOLUME
CONFLUENCE OF
NICHOLS - COOPERS
BROOKS
RMC 1/29/80
AREA
STORAGE
AREA (acres)
STORAGE (A-F)
ELEVATION (FEET ABOVE MSL)
290
260
230
200
170
140
110
80
50
20
824
822
820
818
816
814

Job No. 91116 Sheet 37 of 44
Project Markville Dam Date 1/29/80
Subject Hydraulics By RMc Ch'k. by

REACH 3

X S Approximated from topography
Channel itself neglected due to extreme overbank widths

REACH CHARACTERISTICS

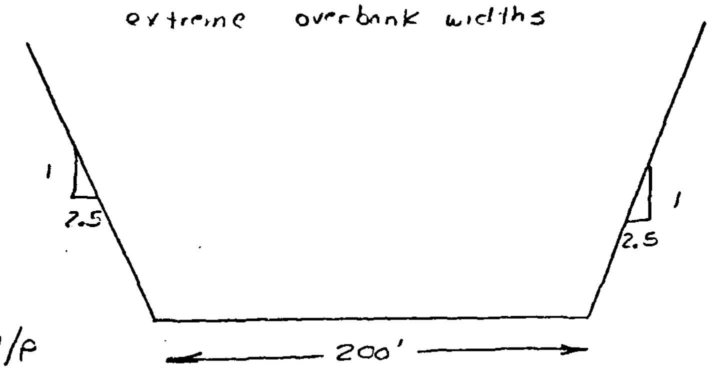
$L = 2600'$

$\Delta elev = 814 - 806 = 8'$

$S = \Delta elev / L = 8/2600 = 0.0031$

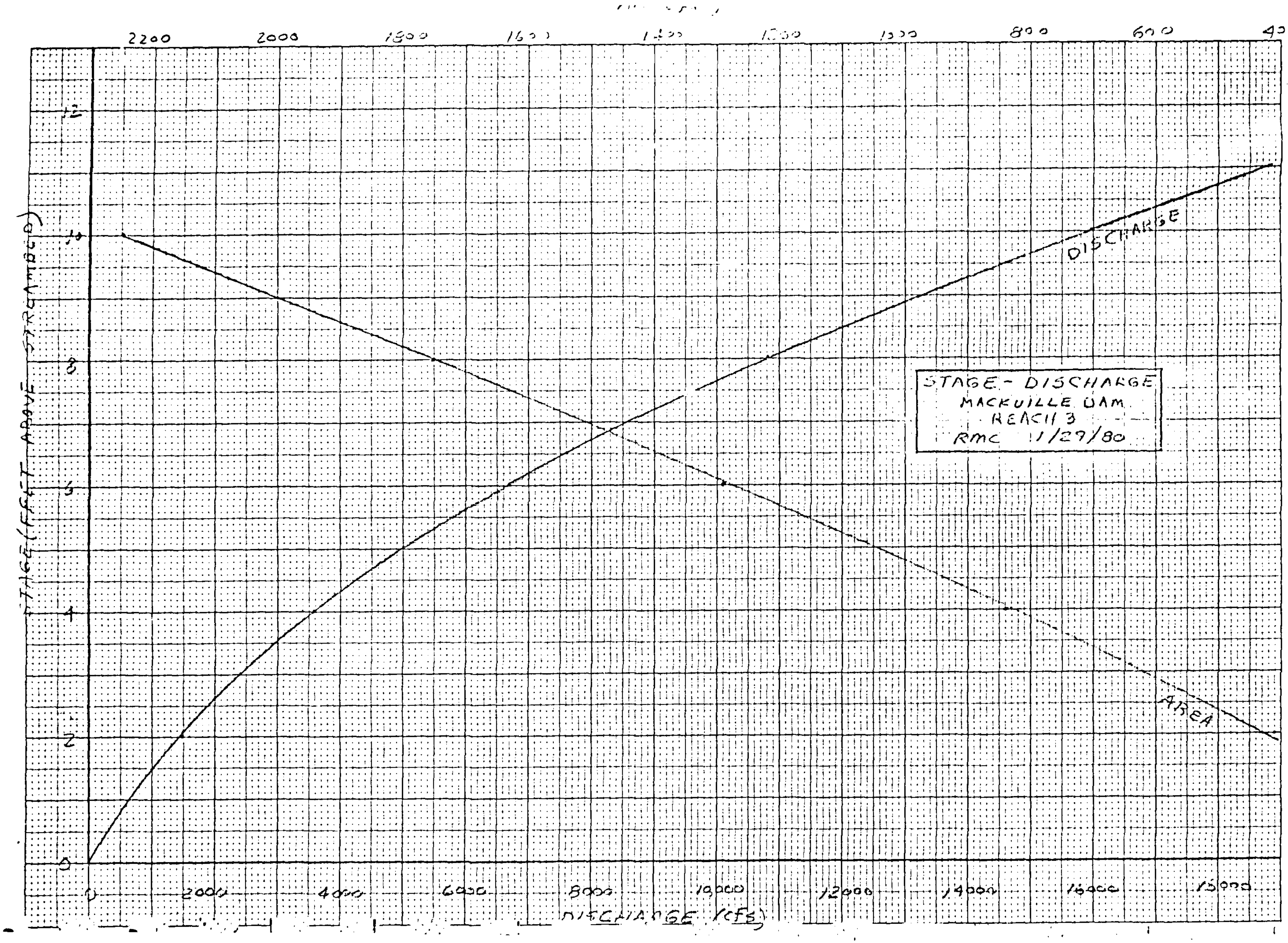
MANNINGS EQUATION USED

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $R = A/P$



$n = 0.05$ Rock channel, Brush overbanks

STAGE (ft)	AREA (ft²)	WETTED PERIMETER (ft)	R	$R^{2/3}$	Q (cfs)
2	410	210.8	1.945	1.559	1061
4	840	221.5	3.792	2.433	3391
6	1290	232.3	5.553	3.138	6716
8	1750	243.1	7.199	3.731	10,833
10	2250	253.9	8.862	4.285	15,997
12	2760	264.6	10.430	4.777	21,676


STAGE - DISCHARGE
MACKVILLE DAM
REACH 3
RMC 11/27/80
DISCHARGE
AREA
STAGE (FEET ABOVE STREAMBED)
DISCHARGE (CFS)
0
2000
4000
6000
8000
10000
12000
14000
16000
2
4
6
8
10
12
2200
2000
800
600

STEP 4 $Q_{P_1} = 10,250$ cfs

ENTER NICHOLS POND REACH 1 (refer p. 23-25)

Stage = 13.7' area = 775 □'

$$V_1 = \frac{10,500' \times 775 □'}{43560 \text{ ft}^2/\text{acre}} = 186.8 \text{ a-f} < \frac{2841}{2} \text{ a-f} \ldots$$

$L_1 = 10,500'$

$$Q_{P_{L\,trial}} = 10,250\left(1 - \frac{186.8}{2841}\right) = 9576 \text{ cfs}$$

stage: 13.3' area: 735 □'

$$V_2 = \frac{735 □' \times 10,500'}{43560} = 177.2 \text{ a-f}$$

$$V_{ave} = (177.2 + 186.8)/2 = 182.0 \text{ a-f}$$

$$Q_{P_2} = 10250\left(1 - \frac{182}{2841}\right) = 9593 \text{ cfs} \approx 9600 \text{ cfs}$$

OUTFLOW = 9600 cfs Stage: 13.3'

(refer p. 26-29)

ENTER MACKVILLE POND, assumed filled to elevation 927.0'

INVESTIGATE SURCHARGE STORAGE EFFECTS ON FLOW

$Q_{P_1} = 9600$ cfs HEIGHT$_1$ = 10.2' (el 935.2) (refer to Mackville Rating Curve, page 28)

V_1 = SURCHARGE STORAGE = 377.5 - 182 = 195.5 a-f

$$Q_{P_2} = Q_{P_1}\left(1 - \frac{V_1}{2841}\right) = 9600\left(1 - \frac{195.5}{2841}\right) = 8939 \text{ cfs}$$

SURCHARGE HEIGHT$_2$ = 9.8' (elev. 934.8')

V_2 = 370 - 182 = 188 a-f

$$Q_{P_2} = 7600 \left(1 - \frac{188}{2841}\right) = 8965 \text{ cfs}$$

SURCHARGE HEIGHT$_3$ = 9.8' (el 934.8')

SURCHARGE HEIGHT$_3$ = SURCHARGE HEIGHT$_2$ = 9.8', NO FURTHER ITERATIONS NECESSARY (NOTE: FLOW DIVIDED IMEDIATELY DS OF DAM)

ENTER REACH 1 - MACKVILLE DAM (Refer p. 30-32)

Q_{P_1} = 8965 cfs stage = 14.4' area = 680 □'

L_1 = 1500'

$$V_1 = \frac{680\,\square' \times 1500'}{43560 \text{ ft}^2/\text{acre}} = 23.4 \text{ a-f} < \frac{2841}{2} \text{ a-f}$$

length, OK

$$Q_{P_{trial}} = Q_{P_1}\left(1 - \frac{V_1}{2841}\right) = 8965\left(1 - \frac{23.4}{2841}\right) = 8891 \text{ cfs}$$

stage = 14.4' area = 680 □'

$$V_2 = \frac{680 \times 1500}{43560} = 23.4 \text{ a-f} = V_{ave}$$

$$Q_{P_2} = 8965\left(1 - \frac{23.4}{2841}\right) = 8891 \text{ cfs}$$

OUTFLOW = 8891 cfs stage = 14.4'

ENTER REACH 2 - MACKVILLE DAM (refer p. 33-34)

Q_{P_1} = 8891 cfs stage = 14.4' area = 495 □'

NOTE: FLOW IS CRITICAL AT THROAT

$$V_1 = \frac{500' \times 495\,\square'}{43560} = 5.7 \text{ a-f} < \frac{2841}{2} \text{ a-f}$$

length$_2$ OK

L_2 = 500'

$$Q_{P_{trial}} = Q_{P_1}\left(1 - \frac{V_1}{2841}\right) = 8891\left(1 - \frac{5.7}{2841}\right) = 8873 \text{ cfs}$$

(normal depth) stage = 11.6' area = 370 □'

$$V_2 = \frac{370 \square' \times 500'}{43560\ ft^2/acre} = 4.3\ a\text{-}f$$

$$V_{ave} = (5.7 + 4.3)/2 = 5\ a\text{-}f$$

$$Q_{P_2} = 8891\left(1 - \frac{5.0}{2841}\right) = 8875\ cfs$$

stage = 11.6' OUTFLOW = 8875 cfs

ENTER CONFLUENCE NICHOLS - COOPERS BROOK (refer p. 35-36)

1) Q_{P_1} = 8875 cfs

2) Rating curve for exit channel controls, from stage-discharge curve d_1 = 7.1'

3) Elevation of valley floor = 814.0 (at exit channel)

4) Elevation of water surface = 814.0 + 7.1 = 821.1'

5) Enter volume-elevation curve, V_1 = storage = 152 a-f < $\frac{2841}{2}$ a-f ∴ OK

$$Q_{P_{2\,trial}} = Q_{P_1}\left(1 - \frac{V_1}{2841}\right) = 8875\left(1 - \frac{152}{2841}\right) = 8400\ cfs$$

d_2 = 6.9' (el 820.9) V_2 = 144.5 a-f

$$V_{ave} = (152 + 144.5)/2 = 148.25\ a\text{-}f$$

$$Q_{P_2} = 8875\left(1 - \frac{148.25}{2841}\right) = 8412\ cfs$$

d_3 = 6.9' (el 820.9) V_2 = 144.5 a-f

$$V_{ave} = (148.25 + 144.5)/2 = 146.38\ a\text{-}f$$

$$Q_{P_3} = 8875\left(1 - \frac{146.38}{2841}\right) = 8418 \text{ cfs}$$

$d_4 = 6.9'$ (el. 820.9')

NO FURTHER ITERATIONS, VALUES WILL NOT CHANGE SIGNIFICAN

OUTFLOW = 8418 cfs stage (@ exit) = 6.9'

ENTER MACKVILLE DAM REACH 3 (Refer p. 37-38)

INFLOW = 8418 cfs stage = 6.9' area = 1480 □'

$$V_1 = \frac{2600' \times 1480□'}{43560 □'/acre} = 88.3 \text{ a-f} < \frac{2841}{2} \text{ a-f}$$

Reach length ok

$L_3 = 2600'$

$$Q_{P\,trial} = 8418\left(1 - \frac{88.3}{2841}\right) = 8156 \text{ cfs}$$

stage = 6.8' area = 1460 □'

$$V_2 = \frac{2600' \times 1460□'}{43560 □'/acre} = 87.1 \text{ a-f}$$

$$V_{ave} = (87.1 + 88.3)/2 = 87.7 \text{ a-f}$$

$$Q_{P_2} = 8418\left(1 - \frac{87.7}{2841}\right) = 8158 \text{ cfs}$$

OUTFLOW = 8158 cfs stage = 6.8'

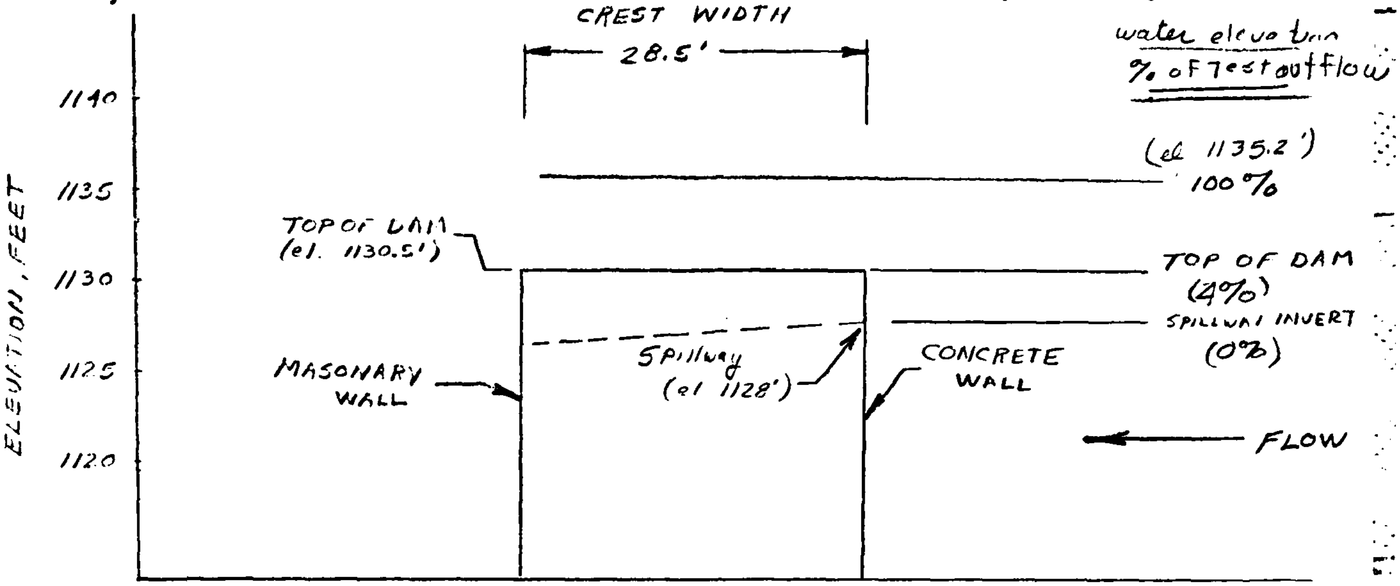
ENTER OUTSKIRTS VILLAGE OF HARDWICK

Job No. 91118 Sheet 43 of 44
Project Nichols Pond Dam Date 1/30/80
Subject Hydraulics By RMC Ch'k. by

FLOOD ROUTING SUMMARY

REACH	DISCHARGE	STAGE	FLOOD WAVE
AT NICHOLS POND DAM	10,250 cfs	13.7'	11.9'
AT CONFLUENCE WITH MACKVILLE POND (10,500' DOWNSTREAM OF NICHOLS DAM)	9600 cfs	13.3'	11.4'
AT MACKVILLE DAM (13,000' DOWNSTREAM OF NICHOLS DAM) REDUCTION BY SURCHARGE STORAGE	8965 cfs		
		assume negligible discharge from Mackville pond	
DOWNSTREAM OF MACKVILLE DAM	8965 cfs	14.4'	14.4'
1500' DOWNSTREAM OF MACKVILLE DAM (14500' DS OF NICHOLS DAM)	8891 cfs	14.4'	14.4'
2000' DOWNSTREAM OF MACKVILLE DAM (15,000' DS OF NICHOLS DAM)	8875 cfs	11.6'	11.6'
3800' DOWNSTREAM OF MACKVILLE DAM (16800' DS OF NICHOLS DAM) AFTER LARGE OPEN AREA	8418 cfs	6.9'	6.9'
6400' DOWNSTREAM OF MACKVILLE DAM (19,400' DOWNSTREAM OF NICHOLS DAM) OUTSKIRTS OF VILLAGE OF HARDWICK	8158 cfs	6.8'	6.8'

Job No. 91118 | Sheet 44 of 44
Project NICHOLS POND DAM | Date 11/29/77
Subject RESERVOIR CAPACITY DATA | By RMC Ch'k. by

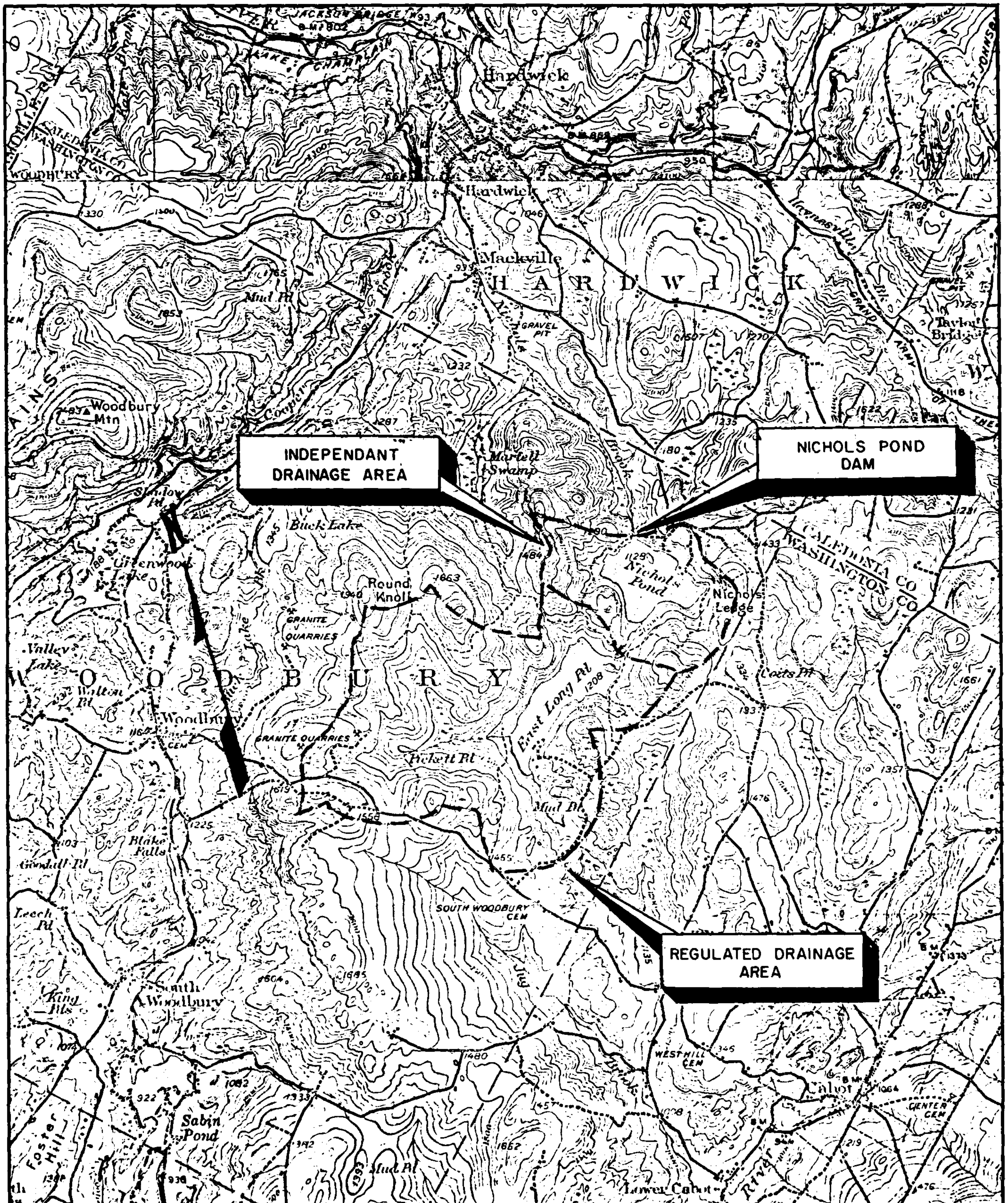


NOT TO SCALE

TEST INFLOW = 8300cfs

SPILLWAY CAPACITY
NICHOLS POND DAM

CONDITION AT DAM	WATER SURFACE ELEVATION	TOTAL DISCHARGE (cfs)	PRIMARY SPILLWAY CONTRIBUTION		EMERGENCY SPILLWAY CONTRIBUTION	
			DISCHARGE (cfs)	% OF TOTAL DISCHARGE	DISCHARGE (cfs)	% OF TOTAL DISCHARGE
ENTIRE CREST OF DAM OVERTOPPED	1135.5	5667	600	10%	N/A	
RESERVOIR FILLED TO DAM CREST	1130.5	218	218	100%		
WATER AT SPILLWAY INVERT	1128	0	0	0%		



DuBois & King inc.
engineering and environmental services
RANDOLPH VERMONT CONCORD NEW HAMPSHIRE

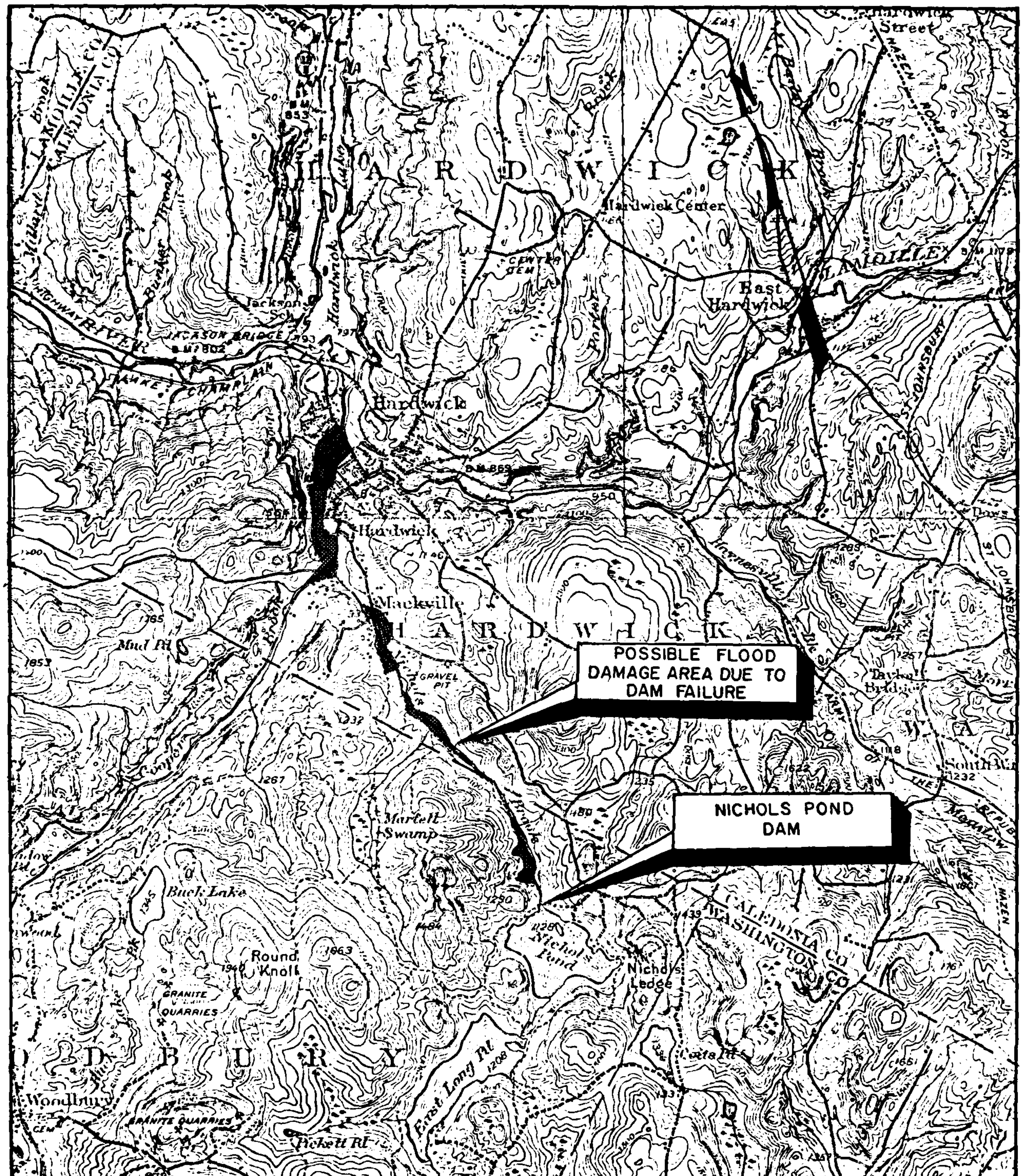
NATIONAL DAM INSPECTION PROGRAM

NICHOLS POND DAM

DRAINAGE AREA

USGS QUAD - PLAINFIELD, VERMONT

DRAWN BY JAS	DATE 12/79
CHECKED BY RMC	PROJ. NO. 91118
PROJ ENG	DRAW. NO.
SCALE: 1":62500	



DuBois & King inc. engineering and environmental services RANDOLPH VERMONT / CONCORD NEW HAMPSHIRE	NATIONAL DAM INSPECTION PROGRAM NICHOLS POND DAM POSSIBLE FLOOD DAMAGE AREA USGS QUAD. - PLAINFIELD, VERMONT	DRAWN BY JAS	DATE 12/79
		CHECKED BY RMC	PROJ. NO. 91118
		PROJ ENG.	DRAW. NO
		SCALE: 1" = 62500	

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

END

FILMED

8-85

DTIC